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IDENTIFIERS	Electrical Wiring; *Power Line Technicians

ABSTRACT

This module is the third in a series that is designed to help students achieve greater professional and personal success as power line technicians. Each module represents one or more complete units of instruction with components organized into one instructor and one student "package": the instructor's manual and the student workbook. The instructor's manual begins with a profile of training mastery that lists the competencies covered in the curriculum and provides space for recording information about the student's mastery of each objective. Other introductory matter includes information on use of the manual, recommendations for measuring student performance gains, and required criteria for a competency-based education program. The instructor's manual also contains one set per unit of these components: suggested activities, answers to assignment sheets, answers to test, transparency masters, and test. The student workbook contains one set per unit of most or all of these components: objective sheet, information sheets, assignment sheets, and job sheets. The five units in this module are as follows: (1) poles, (2) conductors, (3) grounding and connecting, (4) generators and batteries, and (5) work procedures (nonenergized). Most units are designed for use in more than one lesson or class period. (YLB)

ED 403 412

Power Line Technician
Second Edition

Module C

Instructor's Manual
Student Workbook

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Power Line Technician

Second Edition

Module C

- Poles
- Conductors
- Grounding and Connecting
- Generators and Batteries
- Work Procedures (Nonenergized)

CIMC

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Instructor's Manual

Oklahoma Department of Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, OK 74074-4364
http://genesis.okvtecstate.ok.us/cimc/homec.htm

97-012242

TH017

POWER LINE TECHNICIAN
PROFILE OF TRAINING MASTERY

Instructor _____ Date _____

Program _____

Grade _____ School _____

Name _____ Soc. Sec. No. _____

Address _____ Phone _____

In Case of Emergency, Contact _____

Address _____ Phone _____

Allergies/Disabilities that might require special accommodation for training (please specify) _____

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or the general public.

Date of Enrollment ___-___-___ Total Class Hours _____ Total Hours Absent _____

Date of Withdrawal ___-___-___ Total On-the-Job Training Hours _____ Total Hours Tardy _____

Date of Completion ___-___-___ Total Lab Hours _____

ON-THE-JOB TRAINING/WORK EXPERIENCE

Duration of Employment	Job Title	Supervisor's Name
Address of Employer		Phone
Duration of Employment	Job Title	Supervisor's Name
Address of Employer		Phone

Use of This Document

This document can be used to record information about the student and skills mastered. This information is useful in documenting student progress during training and in providing information about the student's qualifications to potential employers and/or for entry into advanced training programs. Instructors using these materials are authorized to reproduce this document as required for use in their training programs.

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SPECIFIC JOB COMPETENCIES

Instructor: As each competency is mastered, place your initials and the date in the blank on the left. This will verify that the student can perform the skill with a minimum of supervision.

MODULE A

Date/Initial

Unit 1 – Orientation to REC

1. Match terms associated with REC orientation to the correct definitions.
2. State the reason for establishing the Rural Electrification Administration.
3. Discuss the importance of rural electric cooperatives.
4. Describe the benefits of rural electric cooperatives to rural America.
5. Select from a list the finance agencies which loan money to rural electric cooperatives.
6. List types of electric utilities.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Introduction to Power Line Technician's Training

1. List responsibilities of a line technician to the community.
2. Select from a list the responsibilities of a line technician to the employer.
3. Select from a list information that is shown on an organizational chart.
4. List departmental functions of a line department.
5. Select from a list topics taught in this course.
6. List benefits to students who complete the line technician's training course.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Job Advancement

1. Match terms associated with job advancement to the correct definitions.
2. List characteristics employers consider when making promotions.
3. Distinguish between good and poor work attitudes.
4. List steps that will help in job advancement.
5. Select from a list benefits of additional education and training.
6. Discuss activities that will better prepare a person for advancement.
7. Discuss reasons people do not succeed on the job.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – General Safety

1. State the safety responsibilities of an REC employee.
2. List the steps of discipline for safety rule violations.
3. Select from a list items which are subject to safety rules.
4. State reasons for the importance of a safety policy.
5. Discuss OSHA regulations for first aid.
6. List the basic steps in first aid.
7. List steps of basic life support.
8. List first aid supplies.
9. List the practices for care of first aid supplies.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE B

Date/Initial

Unit 1 – Personal and Job Safety

1. Match terms associated with personal and job safety to the correct definitions.
2. Describe the procedures to follow for various types of rescue situations.
3. List components necessary for fire.
4. Match classes of fires to the correct description of each.
5. Match types of fire extinguisher to the class or classes of fire each is best suited to extinguish.
6. List general safety precautions to observe during rescue.
7. Discuss in a short paragraph driving skills needed by a line technician.
8. List some poor attitudes that may cause accidents.
9. Select from a list requirements of a skilled driver.
10. List steps of defensive driving.
11. Identify shapes of traffic signs.
12. Select from a list some general safety precautions to observe when operating equipment.
13. State OSHA/DOT regulations for inspection of equipment.
14. Select from a list the items which should be inspected daily on mechanical equipment.
15. List methods for maintaining a clean and orderly work area.
16. Explain how to lift heavy objects.
17. Describe in a short paragraph the importance of safety communications.
18. Select from a list those items of importance that should be reported to the supervisor.
19. Select from a list items related to safety that a line technician should know concerning location and voltage.
20. State factors which determine the maximum weight which can be lifted by equipment.
21. Determine maximum weight that can be lifted by equipment at various angles.
22. Complete a safety pledge form.
23. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Communications

1. List types of communications necessary for an REC employee.
2. Select from a list those items of communication that are important between fellow workers.
3. List items of communication that are important between the worker and the supervisor.
4. Select from a list those items of communication that are important between the worker and the general public.
5. Identify hoist signals.
6. Identify winch line signals.
7. Identify hand signals used in boom operations.
8. Identify hand signals used when maneuvering vehicles.
9. Identify line work signals.
10. Select from a list the proper radio procedures.
11. State emergency radio procedure.
12. Select from a list the prohibited uses of the radio.
13. Match radio code signal numbers to the correct meanings.
14. List factors that are important when using cellular mobile telephones.
15. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Student ratings on specific competencies evaluated during the course are available upon student's written request and/or by calling the instructor. Parent's or guardian's signature is necessary if student is under 18 years of age.

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Date/Initial

Unit 3 – Basic Electrical Theory

1. Match terms associated with basic electrical theory to the correct definitions.
2. List uses of electricity.
3. Discuss the electron theory.
4. Distinguish between alternating and direct current.
5. Match types of magnets to the correct descriptions.
6. State the law of magnetic poles.
7. Describe magnetic force as it relates to production of electricity.
8. Select from a list characteristics of electromagnetic force.
9. Explain the generation of electricity using magnets.
10. Describe electromagnetic induction.
11. Identify types of circuits.
12. Identify conditions of circuits.
13. Name sources of alternating and direct current.
14. Identify divisions of an electrical system.
15. State the relationship among amperage, resistance, and voltage.
16. Solve problems using Ohm's law.
17. Calculate for an unknown voltage.
18. Calculate for an unknown amperage.
19. Calculate for an unknown resistance.
20. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Rope and Rigging

1. Match terms associated with rope and rigging to the correct definitions.
2. Identify parts of a stationary block.
3. List kinds of rope used in line work.
4. Determine the tensile strength of various kinds and sizes of rope.
5. Determine the mechanical advantage of using block and tackle.
6. List uses of various types of rope gear.
7. Apply the formula necessary for the safe working load of various kinds and sizes of ropes when given the tensile strength and safety factory.
8. Identify various knots and hitches.
9. Match various knots and hitches with the correct uses.
10. Identify elements of knots, bends, and hitches.
11. List conditions that damage rope.
12. Calculate the mechanical advantage of using block and tackle.
13. Calculate working load of various ropes.
14. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 5 – Overhead Construction

1. Match terms associated with overhead construction to the correct definitions.
2. Match materials commonly used in overhead construction to their specific uses.
3. Identify hand tools commonly used in overhead construction.
4. Match hand tools to their specific uses.
5. Identify overhead construction tools.
6. Match overhead construction tools to their specific uses.
7. List elements of overhead construction.
8. List equipment used in overhead construction.
9. Match equipment commonly used in overhead construction to their specific uses.
10. Select from a chart the correct depth to set poles of varying lengths.
11. List methods used to properly sag conductors.
12. Identify various types of connectors used in overhead construction.
13. Match types of construction to the correct descriptions.
14. List steps to properly install a pole key.
15. State correct procedure for installing a ground rod.
16. Arrange in order the steps to follow when framing a pole.
17. Identify various structures used in transmission line construction.
18. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 6 – Underground Distribution Construction

1. Match terms associated with underground construction to the correct definitions.
2. Identify equipment used in underground construction.
3. Match various types of equipment to the specific uses.
4. List general requirements for underground construction.
5. Arrange in order the correct procedure for installing cable.
6. List precautions to observe when handling underground cable.
7. Select from a list methods of marking cable for identification.
8. List methods used to locate and identify a utility ditch.
9. Identify equipment used to terminate primary cable on a pole.
10. State the requirement for grounding underground equipment.
11. List hazards which may be encountered in underground construction.
12. List precautions to observe when splicing or terminating cable.
13. Select from a list the tools used in underground construction.
14. Make a proper splice in secondary cable.
15. Make a proper splice in primary cable.
16. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 7 – Personal Climbing Tools and Equipment

1. Match terms associated to personal climbing tools and equipment to the correct definitions.
2. Identify personal climbing tools and equipment.
3. Match tools and equipment to the specific use.
4. List conditions to watch for when inspecting personal climbing tools and equipment.
5. Name types of maintenance for personal climbing tools and equipment.
6. List safety precautions to observe when climbing poles.
7. Select from a list the general procedure for climbing poles.
8. Name rules for safe and proper storage of personal tools and equipment.
9. Climb poles.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 8 – Right-Of-Way

1. Match terms associated with right-of-way clearing and control to the correct definitions.
2. List methods to maintain good public relations.
3. Identify tools used for right-of-way clearing and control.
4. State the purposes of right-of-way control.
5. Select from a list the safe working procedures for right-of-way clearing and control.
6. Select proper methods of tree trimming.
7. List steps to remove limb hanging over an energized conductor.
8. List steps to fell a tree.
9. State the specifications for clearing right-of-way for distribution line.
10. List types of clearing and chemical control for right-of-way.
11. Identify various trees that grow rapidly.
12. Identify poisonous vegetation.
13. Draw cuts needed to remove heavy limbs.
14. Draw procedure for removing limb hanging over energized conductor.
15. Draw procedure for felling a tree.
16. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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Date/Initial

Unit 9 – Distribution Transformers

1. Match terms associated with transformers to the correct definitions.
2. State the functions of a transformer.
3. Identify parts of a completely protected transformer.
4. Distinguish between additive and subtractive polarity as they relate to transformers.
5. List kinds of transformers.
6. Match types of transformers to the correct descriptions.
7. Classify types of transformers as oil-cooled or air-cooled.
8. Discuss technical considerations in protective grounding and jumpering.
9. List information found on a transformer nameplate.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE C

Date/Initial

Unit 1 – Poles

1. Match terms associated with poles to the correct definitions.
2. List five types of preservatives used on poles.
3. Match the type of preservatives used on poles with their code letters.
4. Select from a table the classes of poles of varying lengths and circumferences.
5. Select from a list precautions to observe when handling poles.
6. Calculate the weights of various classes and lengths of commonly used poles using a table.
7. List methods used to set poles.
8. State the correct procedure for checking a pole before climbing.
9. Arrange in proper order the steps for pole inspection.
10. List methods used to support unsafe poles for climbing.
11. State the correct method for storing poles.
12. Select from a table the classes of poles of varying lengths and circumferences.
13. Calculate the weights of various classes and lengths of commonly used poles using a table.
14. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Conductors

1. Match terms associated with line conductors to the correct definitions.
2. List methods used to protect line conductor at supports.
3. Arrange in order the steps to follow when joining ACSR conductors.
4. Arrange in order the steps to follow when joining CWC conductors.
5. List classes of conductors.
6. List methods of reeling our conductor.
7. Identify various types of conductor ties.
8. Match types of conductors to their specific use.
9. State conductor clearance from ground, roofs and building walls for conductors carrying 750 volts or less.
10. State conductor clearance from ground for conductors carrying over 750 volts to 22,000 volts.
11. Match current-carrying capacities of various ACSR conductors to the correct conductor size.
12. Match current-carrying capacities of various copperweld copper conductors to the correct conductor size.
13. Install a preformed line tie on ACSR conductor on a de-energized circuit.
14. Install a top groove conductor tie on a de-energized copper conductor.
15. Install a preformed armor rod on ACSR conductor.
16. Join ACSR conductor.
17. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Grounding and Connecting

1. Match terms associated with grounds and connectors to the correct definitions.
2. State the purposes of grounding.
3. List methods of grounding.
4. Select from a list those elements necessary for good grounding.
5. Select from a list equipment which must be grounded.
6. State the correct procedure for installing temporary protective grounds.
7. Arrange in order the steps to follow when disconnecting and grounding at sectionalizer or recloser station.
8. Arrange in order the steps to follow when disconnecting and grounding at multiphase vertical corner.
9. State the procedure for installing temporary protective grounds at air-break switch on a transmission line.
10. List elements of a good connection.
11. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Generators and Batteries

1. Match terms associated with generators and batteries to the correct definitions.
2. List kinds of generating plants.
3. Match kinds of generators to the voltages produced by each.
4. Match kinds of generators to the specific uses.
5. Calculate the frequency (Hertz) of various generators.
6. List precautions to observe with the use of portable generators.
7. List types and kinds of voltage-producing cells.
8. Identify various circuits of connected batteries.
9. Select from a list precautions to observe when connecting batteries.
10. Arrange in order the steps to follow to connect lead-acid batteries when starting equipment.
11. Connect batteries in series and parallel.
12. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 5 – Work Procedures (Nonenergized)

1. Match terms associated with work procedures to the correct definitions.
2. Select from a list information found on a staking sheet.
3. Arrange in proper order the procedure for line construction.
4. List steps to follow when installing service wire.
5. State the procedure for connecting service wire.
6. Match the materials needed to construct primary and neutral assemblies using ACSR conductor 7.2kV construction.
7. List materials needed to install various pole ground assemblies.
8. List materials needed for various primary assemblies.
9. List materials needed to complete a work order.
10. Identify section numbers within a township.
11. Locate rural property in Oklahoma using legal descriptions.
12. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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MODULE D

Date/Initial

Unit 1 – Insulation

1. Match terms commonly associated with insulators and insulation to their correct definitions.
2. List steps to follow when installing a pin type insulator.
3. Select from a list methods of insulating distribution voltages.
4. Select from a list methods of insulating various transmission voltages on wooden structures.
5. Match insulative materials to their specific uses.
6. Select from a list precautions to observe with insulators and insulation.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Substations

1. Match terms commonly used with substations to the correct definitions.
2. State functions of a substation.
3. Identify components of a substation.
4. Match components of a substation to their specific use.
5. Arrange in order the steps for taking a substation out of service.
6. Select from a list precautions to observe with a substation.
7. Arrange in order the correct procedure for changing a substation oil circuit recloser.
8. State the correct procedure for bypassing a substation current transformer.
9. List indications in a substation that could cause an outage.
10. Match indications to problems which may occur in substations.
11. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Ground and Jumpers (Line Equipment)

1. Match terms commonly used with grounds and jumpers to the correct definitions.
2. Match types of jumpers to their specific use.
3. State requirements for various jumpers.
4. Select from a list the line equipment that is connected by jumpers.
5. Match types of jumpers to the correct installation methods.
6. State the requirements for safe grounding of line equipment.
7. Distinguish between proper and improper grounding methods.
8. Calculate current flow of faulted equipment which is improperly grounded.
9. Calculate voltage on improperly grounded faulted equipment.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Voltage and Current Measuring

1. Match terms commonly used with voltage and current measurements to the correct definitions.
2. State the purposes of voltage and current measurements.
3. Identify equipment used for voltage and current measurements.
4. State the correct procedure for determining voltage drop of a service.
5. State the correct procedure for determining current demand on a primary circuit in a specific area.
6. State procedures for determining current demand on a transformer.
7. List steps to obtain primary line voltage drop.
8. Select from a list reasons for current measurements.
9. Match full load secondary current at 240 volts single phase to the kVA ratings of a transformer.
10. Select from a list precautions to observe when making voltage and current measurements.
11. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE E

Date/Initial

Unit 1 – Meters and Meter Application

1. Match terms commonly associated with metering to the correct definitions.
2. List general types of meters.
3. List types of meters by base construction.
4. List classes of meters and the current-carrying capacity of each.
5. Match meters to types of service.
6. Match meter to voltage ratings to types of service.
7. Match abbreviations and symbols used with metering circuit diagrams to the correct meanings.
8. List uses of current transformer metering.
9. List uses of self-contained meter connections.
10. Identify various self-contained meter connections.
11. Identify various transformer-rated meter connections.
12. Identify various transformer-rated meter connections for 600 volts or above.
13. State the procedure for selecting the correct meter.
14. List methods for determining voltage for wye and delta connected meters.
15. Match types of services to specific uses.
16. List types of meters which have multipliers.
17. Arrange in order the correct procedure for determining meter mutipliers.
18. List precautions to observe with metering.
19. Calculate the multiplier for a transformer-rated meter connected to a secondary line.
20. Calculate the multiplier for a transformer-rated meter connected to a primary line.
21. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – System Knowledge

1. Match terms used with system knowledge to the correct definitions.
2. Define symbols used with overhead lines and equipment identification on system maps.
3. Define symbols used with underground lines and equipment identification on system maps.
4. Identify symbols used to locate cultural features on system maps.
5. List functions of automated equipment.
6. List precautions to observe with automated equipment.
7. Select from a list conditions associated with system terrain.
8. Identify symbols on a system map.
9. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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Date/Initial

Unit 3 – Transformer Connections and Banking

1. Match terms commonly used with transformer connections and banking to the correct definitions.
2. Define characteristics of transformer construction.
3. Match symbols used with transformer voltage rating and connection diagrams to the correct meanings.
4. Discuss transformer polarities.
5. Discuss bushing locations in relationship to polarity on padmount transformers and compare to pole-type in regard to subtractive and additive.
6. Identify secondary coil connections for two- and three-wire service.
7. Identify single-transformer connections for three-wire service.
8. Identify two-transformer banks.
9. Define objectives an electrician must keep in mind when constructing three-phase banks.
10. List in order the step-by-step process for designing three-phase banks.
11. Describe phase relationships between the bushings in three-phase banks.
12. Identify types of primary and secondary connections for three-transformer banks.
13. List precautions to observe when selecting transformers to be banked or paralleled.
14. Identify secondary connections on a four-bushing transformer.
15. State the correct method of connecting wye and delta transformers to a primary line.
16. Arrange in order the steps to find a faulted transformer in a bank.
17. State the precautions to observe with transformer banks.
18. Connect transformer secondary coils in series and parallel.
19. Connect a wye-delta bank for three-phase four-wire 120/240-volt service.
20. Connect a wye-delta bank for three-phase three-wire 240-volt service.
21. Connect a wye-wye bank for three-phase four-wire 120/208-volt service.
22. Connect an open-wye open-delta bank for three-phase four-wire 120/240-volt service.
23. Connect an open-wye open-delta bank for three-phase three-wire 240-volt service.
24. Connect an open-delta open-delta bank for three-phase four-wire 120/240-volt service.
25. Connect two single-bushing transformers in parallel.
26. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Phasing

1. Match the terms commonly associated with phasing to the correct definitions.
2. List elements of phasing.
3. State methods of determining phase rotation.
4. State the procedure for changing the direction of rotation of a three-phase motor.
5. Arrange in order the steps to follow when phasing circuits with a phasing meter.
6. Arrange in order the steps to follow to identify distribution phases.
7. Label substation distribution phases.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE F

Date/Initial

Unit 1 – Line Patrol

1. Match types of line patrol to the specific purpose.
2. Select from a list items to observe when patrolling line.
3. Match items to the specific conditions to observe when patrolling a line.
4. List methods of line patrol.
5. Select from a list requirements of a line patroller.
6. List items to observe with line equipment.
7. Complete a line inspection form.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Electrical Equipment

1. Match terms used with electrical equipment to the correct definitions.
2. Match electrical equipment to the specific uses.
3. Arrange in order the steps to follow when connecting a voltage regulator to a three-phase line.
4. Arrange in order the steps to follow when placing a voltage regulator in service.
5. State the procedure for setting voltage regulator time delays.
6. State the procedure for taking a voltage regulator out of service.
7. List precautions to observe with voltage regulators.
8. List precautions to observe with capacitors.
9. Select from a list the benefits of capacitor application
10. Name equipment that should be protected by lightning arresters.
11. Explain the method of coordinating reclosers with other reclosers.
12. List precautions to observe when installing sectionalizers.
13. Select from a list factors to consider when coordinating reclosers and fuses.
14. Connect voltage regulators to a three-phase line.
15. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Work Procedures (Hot Line, Basket, Hot Stick)

1. List methods of hot line maintenance.
2. Select from a list OSHA requirements for aerial devices.
3. Select from a list rules to observe when working with aerial devices.
4. List elements of hot line maintenance.
5. State the procedure for hot line maintenance from an aerial device.
6. Arrange in order the steps to follow when changing a pole top insulator from a basket.
7. Match various hot line tools to their specific uses.
8. Install a wire tong saddle.
9. Change an insulator on an energized conductor using hot line tools on an A1 structure.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Troubleshooting (Secondary)

1. Match terms associated with troubleshooting to the correct definitions.
2. Match indications of malfunctions to the possible causes.
3. Arrange in order the correct procedure for troubleshooting electrical equipment.
4. List precautions to observe when troubleshooting electrical equipment.
5. Select from a list items of information to obtain while troubleshooting.
6. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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MODULE G

Date/Initial

Unit 1 – Troubleshooting (Primary Line)

1. Match troubleshooting problems to possible causes.
2. Arrange in order the troubleshooting procedures to follow for various problems.
3. List precautions to observe when troubleshooting primary lines.
4. Arrange in order the steps for troubleshooting a primary line outage.
5. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – System Knowledge

1. List problems associated with line switching.
2. Arrange in order the steps to follow when switching line.
3. List factors involved in line switching.
4. Select from a list precautions to observe with line voltage regulators on a switched line.
5. List precautions to observe when opening a line switch.
6. Select from a list areas and locations of importance to the line technician.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Conversions

1. List types of conversions.
2. Arrange in order the steps to convert a primary line to a higher voltage.
3. Arrange in order the steps to change a substation feed area to a higher voltage.
4. Explain benefits of converting to a higher voltage.
5. Select from a list precautions to observe with autotransformers.
6. Arrange in order the steps to convert a single-phase line to V-phase.
7. Arrange in order the steps to convert a single-phase line to three-phase.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

BEST COPY AVAILABLE

Power Line Technician: Module C

Instructor's Manual

Upfront

Suggested Activities

Answers to Assignment Sheets

Answers to Test

Transparency Masters

Test

Developed by the
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education

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TI1017

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Curriculum and Instructional Materials Center

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Instructor's Manual

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One set per unit of the following components:

- Suggested Activities
- Answers to Assignment Sheets
- Answers to Test
- Transparency Masters
- Test

Student Workbook

One set per unit of Objective Sheets, Information Sheets, Assignment Sheets, and Job Sheets for each of the units in this module:

MODULE A

1. Orientation to REC
2. Introduction to Power Line Technician's Training
3. Job Advancement
4. General Safety

MODULE B

1. Personal and Job Safety
2. Communications
3. Basic Electrical Theory
4. Rope and Rigging
5. Overhead Construction
6. Underground Distribution Construction
7. Personal Climbing Tools and Equipment
8. Right-of-Way
9. Distribution Transformers

MODULE C

1. Poles
2. Conductors
3. Grounding and Connecting
4. Generators and Batteries

5. Work Procedures (Nonenergized)

MODULE D

1. Insulation
2. Substations
3. Grounds and Jumpers (Line Equipment)
4. Voltage and Current Measuring

MODULE E

1. Meters and Meter Application
2. System Knowledge
3. Transformer Connections and Banking
4. Phasing

MODULE F

1. Line Patrol
2. Electrical Equipment
3. Work Procedures (Hot Line, Basket, Hot Stick)
4. Troubleshooting (Secondary)

MODULE G

1. Troubleshooting (Primary Line)
2. System Knowledge (Phase II)
3. Conversions

FOREWORD

The *Power Line Technician* series is designed to help students achieve greater professional and personal success. As a tool for building a rewarding career, this series will help students develop their professional competence. In addition, the series provides a foundation for career advancement. The *Power Line Technician* series consists of seven modules which address specific skill areas. Each module represents one or more complete units of instruction with components organized into one student and one instructor "package": the *Student Workbook*, and the *Instructor's Manual*. We believe the format and packaging will facilitate both the delivery and mastery of the identified competencies.

We hope that this series will enhance instruction and contribute to rewarding learning experiences for all students.

Roy Peters, Jr.
State Director
Oklahoma Department of
Vocational and Technical Education

Ivan Armstrong
State Supervisor
Trade and Industrial Education

ACKNOWLEDGMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to the individuals who played key roles in the development of this publication. Such a comprehensive effort requires contributions from many people. We sincerely appreciate the support necessary to complete this project.

Design: Special thanks are extended to the representatives from industry, teaching, and vocational education who participated as members of the curriculum advisory committees for the *Power Line Technician* series. We also thank the administrators, supervisors, and others who supported their participation. Significant contributions were made during the revision process by participants from ABB Power T&D Company Inc., the Association of Missouri Electric Cooperatives, the Central Rural Electric Cooperative (Stillwater, Oklahoma) and the City of Stillwater.

Development: The modules in this series were edited by Craig Maile and Dr. Lois Sharpton. Individual modules were formatted by Vonda Gile. Brenna Tillman, Publications Supervisor in the CIMC, assisted in adapting the packaging.

Production: The close cooperation and dedication of professionals at the Oklahoma Department of Vocational and Technical Education were instrumental in producing the *Power Line Technician* series. Unit and cover artwork were designed by the Art Department, under the direction of Bob Davis, Art Manager. This series could not have been printed without the expertise and commitment of the Printing Plant Staff, under the direction of Danny Darrow. Delivering the final product was accomplished through the excellence of the CIMC Customer Service staff and the staff of the CIMC Warehouse, under the direction of Darrell Stiles.

Support: A number of people at the CIMC helped to make this series possible. Terri Tomson efficiently handled the development contracts, committee meetings, and correspondence relating to this series. This project also received generous support from John Friedemann, CIMC Team Leader, and Dr. Lynna Ausburn, Development Coordinator.

Project Management: Dr. Marilyn Troupe and Craig Maile

USE OF THIS PUBLICATION

Each unit of instruction is based on the performance needed for successful employment in an occupational area. A complete unit will contain most or all of the following components: Objective Sheet, Suggested Activities, Information Sheet, Assignment Sheet, Job Sheet, Test, Answers to Assignment Sheets, Answers to Test, and Transparency Masters. These components are organized within two packages, as follows:

Instructor's Manual

- Upfront pages
- One set per unit of:
  - Suggested Activities
  - Answers to Assignment Sheets
  - Answers to Test
  - Transparency Masters
  - Test

Student Workbook

- Objective Sheets
- Information Sheets
- Assignment Sheets
- Job Sheets

Instructor's materials include the *Instructor's Manual* and the *Student Workbook*.

Unit components are tied to measurable and observable learning outcomes. Instructors are encouraged to supplement unit components with other resources to make units as responsive to local conditions and student needs as possible.

Most units of instruction are designed for use in more than one lesson or class period. Instructors should determine the following for each unit:

- amount of material that can be covered in each class period;
- skills that must be demonstrated;
- supplies and equipment needed;
- amount of class time needed for demonstrations;
- amount of class time needed for student practice;
- supplementary materials to be ordered; and
- resource persons who must be contacted.

Objective Sheet (Student Workbook)

The Objective Sheet summarizes each unit for the student and the instructor. The Objective Sheet includes the following sections:

> **Unit Objective** – The Unit Objective states the overall goal of the unit. It identifies what the student will be able to do after successfully completing the unit, as well as the standards used to measure student performance.
>
> **Specific Objectives** – The Specific Objectives outline the teaching sequence of the competencies required to reach the Unit Objective.

The Specific Objectives on the Objective Sheet should be emphasized to all students at the start of each unit and throughout the teaching/learning process. This will help answer student questions about performance requirements for each unit. Specific Objectives can also assist instructors in determining teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could best be taught.

Instructors should modify, delete, or add objectives to meet the needs of students and the community. When objectives are added, the instructor should remember to provide the needed information, Assignment and/or Job Sheets, and criterion-referenced test items to cover the new objectives.

Information Sheet (Student Workbook)

The Information Sheet provides the "must know" content essential for meeting the cognitive objectives in the unit. The Information Sheet may include clarifying NOTES and EXAMPLES, as needed. Students should read the Information Sheet for each unit before it is discussed in class.

Assignment Sheets (Student Workbook)

The Assignment Sheets address the learning levels at or above the application level of Bloom's taxonomy. They allow students to perform non-psychomotor activities related to occupational tasks. Assignment Sheets also provide students with an opportunity to use higher-order thinking skills, such as problem-solving, synthesizing, analyzing, and evaluating. In addition, they may provide opportunities for cooperative learning and more detailed oral/written communication activities.

Job Sheets (Student Workbook)

Job Sheets give students step-by-step procedures for performing manipulative or psychomotor occupational tasks or jobs. The Job Sheet also facilitates the instructor's evaluation of each student's performance. Both the process and the end-product are evaluated. Diagrams, illustrations, and photographs are included, as needed, to assist students in completing the job.

The instructor should demonstrate the procedure outlined in each Job Sheet. Instructors may also have to localize specific procedures.

Suggested Activities (Instructor's Manual)

Instructors should study the Suggested Activities before introducing the unit, allowing enough time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Specific tasks of the instructor will vary with each unit.

Answers to Assignment Sheets and Answers to Test (Instructor's Manual)

These components list the answers to all of the Assignment Sheets and the Test questions.

Transparency Masters (Instructor's Manual)

Transparency Masters are provided so that instructors can make transparencies to accompany specific units. Transparencies allow students to *see* as well as hear the information being presented, thus reinforcing the learning process. They also direct attention to the topic under discussion. Transparencies should be left on the screen only when the related topics are under discussion.

Test (Instructor's Manual)

The Test provides criterion-referenced evaluation of the Specific Objectives from the Information Sheet (Assignment Sheet and Job Sheet objectives are not evaluated by the Test). If instructors have added, deleted, or modified any objectives, appropriate changes should be made to the Test as well.

The Test serves as both a pretest and a posttest. In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *essential* that the same test be used as a pretest and as a posttest. If instructors choose to use tests other than the unit Test, they should make sure that the same instrument is used for each activity – pre- and posttest.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication *Measuring Learning & Competency Gains: The Pretest/Posttest Approach*. This booklet – and accompanying software to assist in calculating and recording student gains – are available to Oklahoma instructors through their school's vocational testing liaison.

Profile of Training Mastery

The Profile of Training Mastery documents student performance. Each profile lists the competencies covered in the curriculum, and provides space for recording information about the student and the student's mastery of each objective. Space is also provided for recording pre- and posttest scores, modified gains, and instructor comments. A blank Profile of Training Mastery is available for this series. It may be reproduced for each student.

Page Numbering

Each Module is identified with a letter (A - G). Each unit and page has a number, shown in Arabic numerals. For example, the page number for Module A, Unit 2, page 3 of the *Student Workbook* would appear as follows:

PLT A - 2 - 3

Methods of Disseminating Material

For best results, provide each student with a copy of the Student Workbook. Students should be allowed to keep their Workbooks at the end of the course or training program.

Teaching Methods

Keeping students motivated is a challenge. Supplement each unit with current information, personal experiences, and other information. In a group setting, prepare for each unit by determining the best way to teach each objective, and allow for student input. For individualized instruction, provide opportunities for the student to become involved in planning and being responsible for his or her own education.

MEASURING STUDENT PERFORMANCE GAINS

Each CIMC unit contains only a single unit Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach*. In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	**Discussion**	**CIMC component meeting criterion**
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives.	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Test and Job Sheet

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Profile of Training Mastery

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with accurate and effective materials. Although the CIMC strives to maintain the highest standards of development and production, oversights sometimes do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. To do this, please identify the page(s) affected and write any comments to clarify the error or suggestion. Use the spaces below. Then, simply fold (bottom of page *upward*, top *downward*), secure, and mail.

This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

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Page: Comment:

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POLES
UNIT 1

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information and assignment sheets.
   - Make transparencies.
   - Discuss unit and specific objectives.
   - Discuss information and assignment sheets.
   - Give test.

2. Unit references:

   - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook.* 8th ed. New York: McGraw-Hill Book Co., 1992.
   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

POLES
UNIT 1

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. 4
2. 6
3. 2
4. 4

Assignment Sheet 2

1. 844 lbs
2. 6034 lbs
3. 454 lbs
4. 2438 lbs
5. 9770 lbs

POLES
UNIT 1

ANSWERS TO TEST

1. a. 5 f. 9
   b. 4 g. 6
   c. 7 h. 1
   d. 8 i. 3
   e. 2

2. a. Creosote oil
   b. Pentachlorophenol
   c. Chromated copper arsenates (CCA)
   d. Ammoniacal copper fatty acid
   c. Copper naphthenate

3. a. 5 e. 4
   b. 6 f. 3
   c. 2
   d. 1

4. a. 2
   b. 5
   c. 4
   d. 3

5. a, c, d, e, f, g, h, i

6. a. 921 d. 862
   b. 660 e. 454
   c. 1004

ANSWERS TO TEST

7. a. Pike
   b. Gin pole
   c. A-frame
   d. Boom or digger derrick

8. a. Check pole brand for proper depth
   b. Inspect pole visually for unauthorized attachments and cracked or broken insulators
   c. Sound pole with hammer
   d. Check for woodpecker holes and loose hardware

9. a. 6
   b. 1
   c. 2
   d. 3
   e. 5
   f. 4

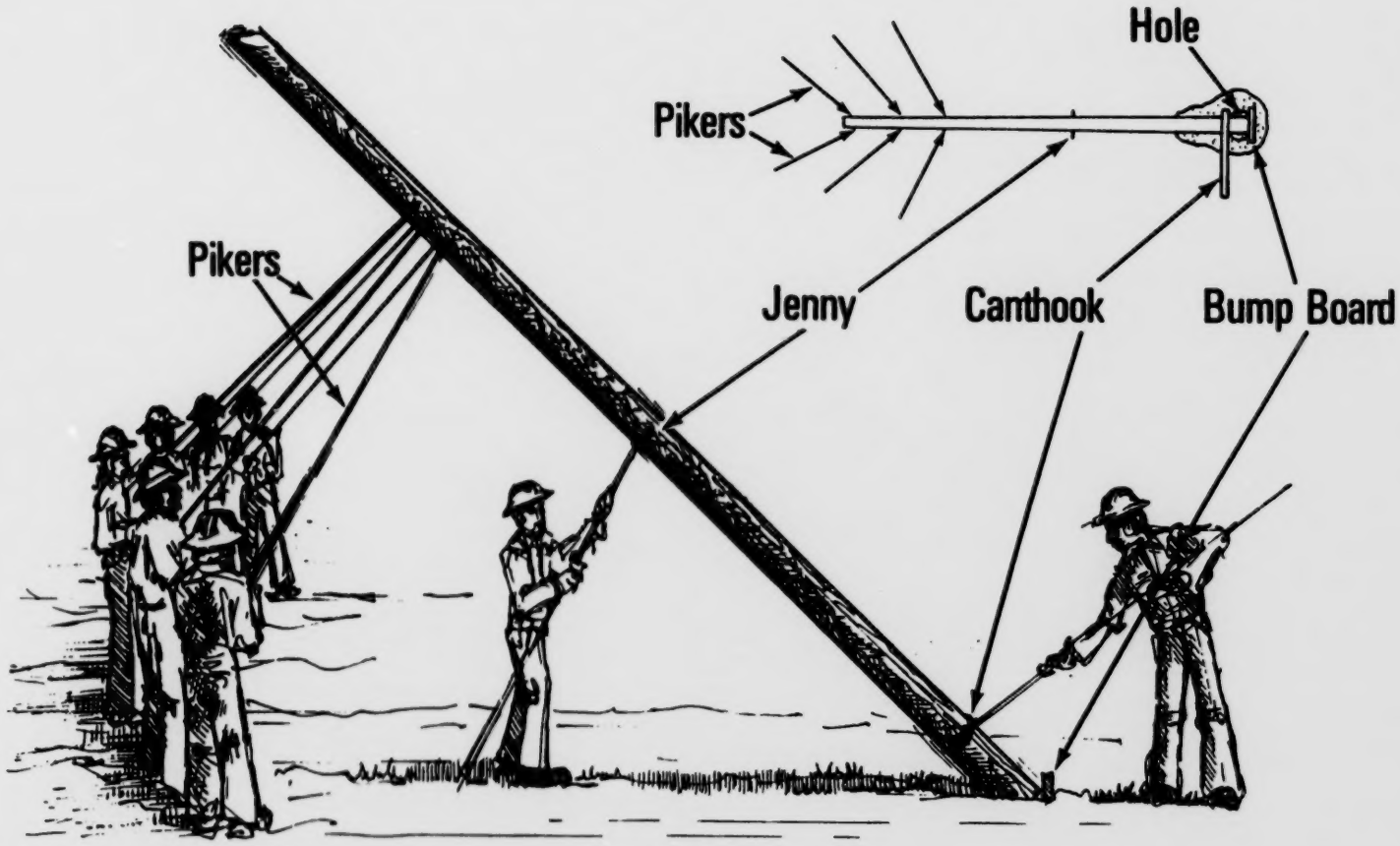
10. (NOTE: Any three of the following methods are acceptable.)
   a. A-frame and metal stub
   b. Temporary guy
   c. Digger derrick
   d. Pole pike
   e. Pole stub

11. Poles should be stored on racks with each layer separated or laid at a right angle to the layer below to allow for circulation of air.

12. Evaluated on Assignment Sheet 1.

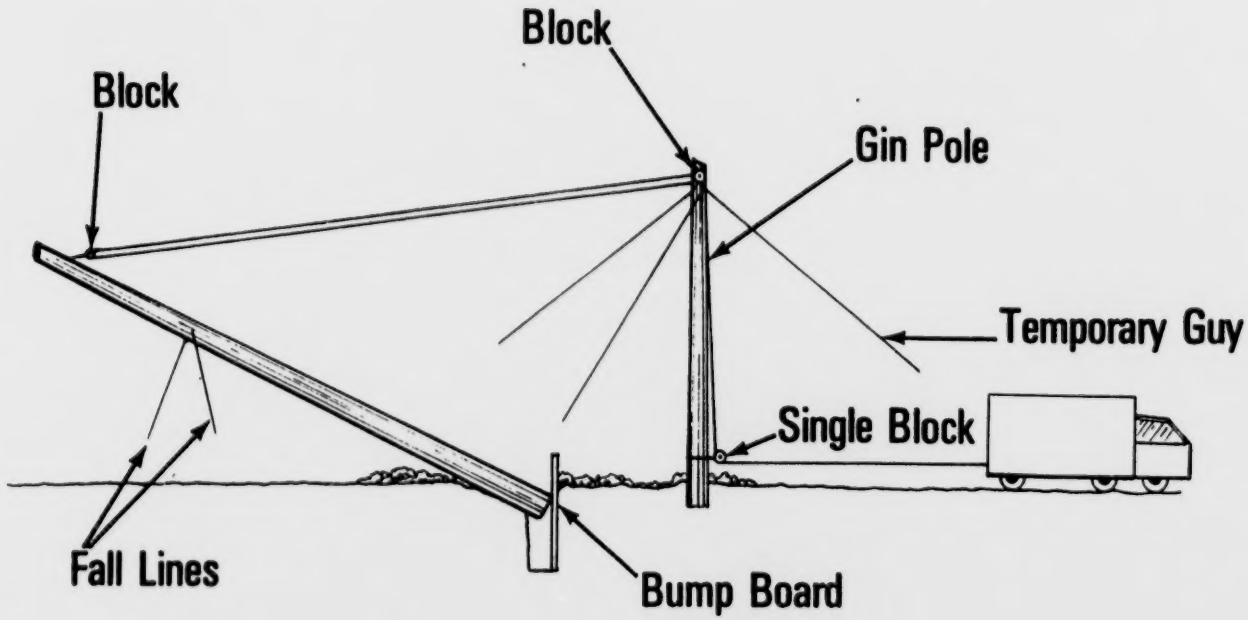
13. Evaluated on Assignment Sheet 2.

Setting Pole With Pikes



May be photocopied for student use.

Setting Pole With Gin Pole



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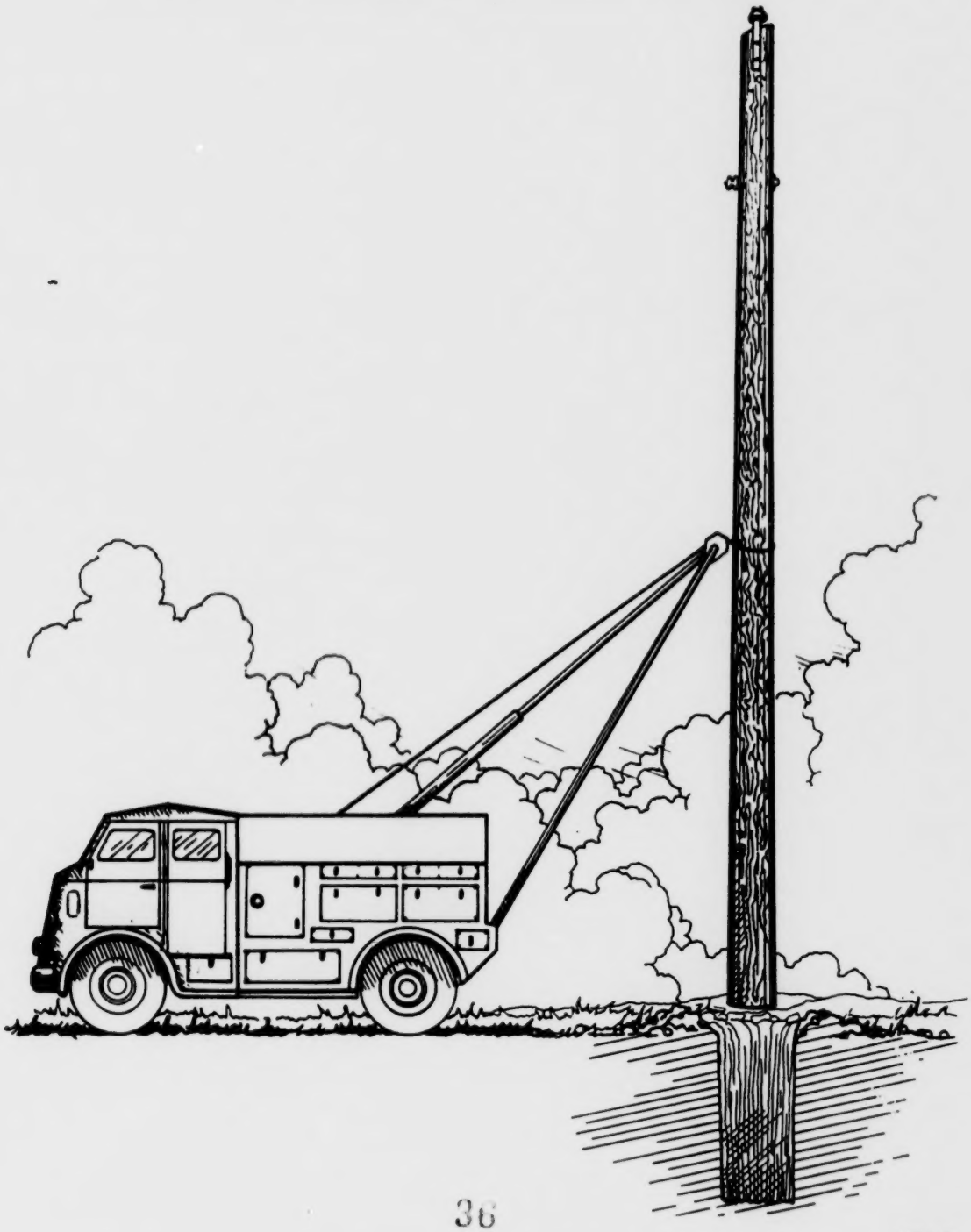
Setting Pole With A-Frame



TM 3

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Setting Pole With Boom

TM 4

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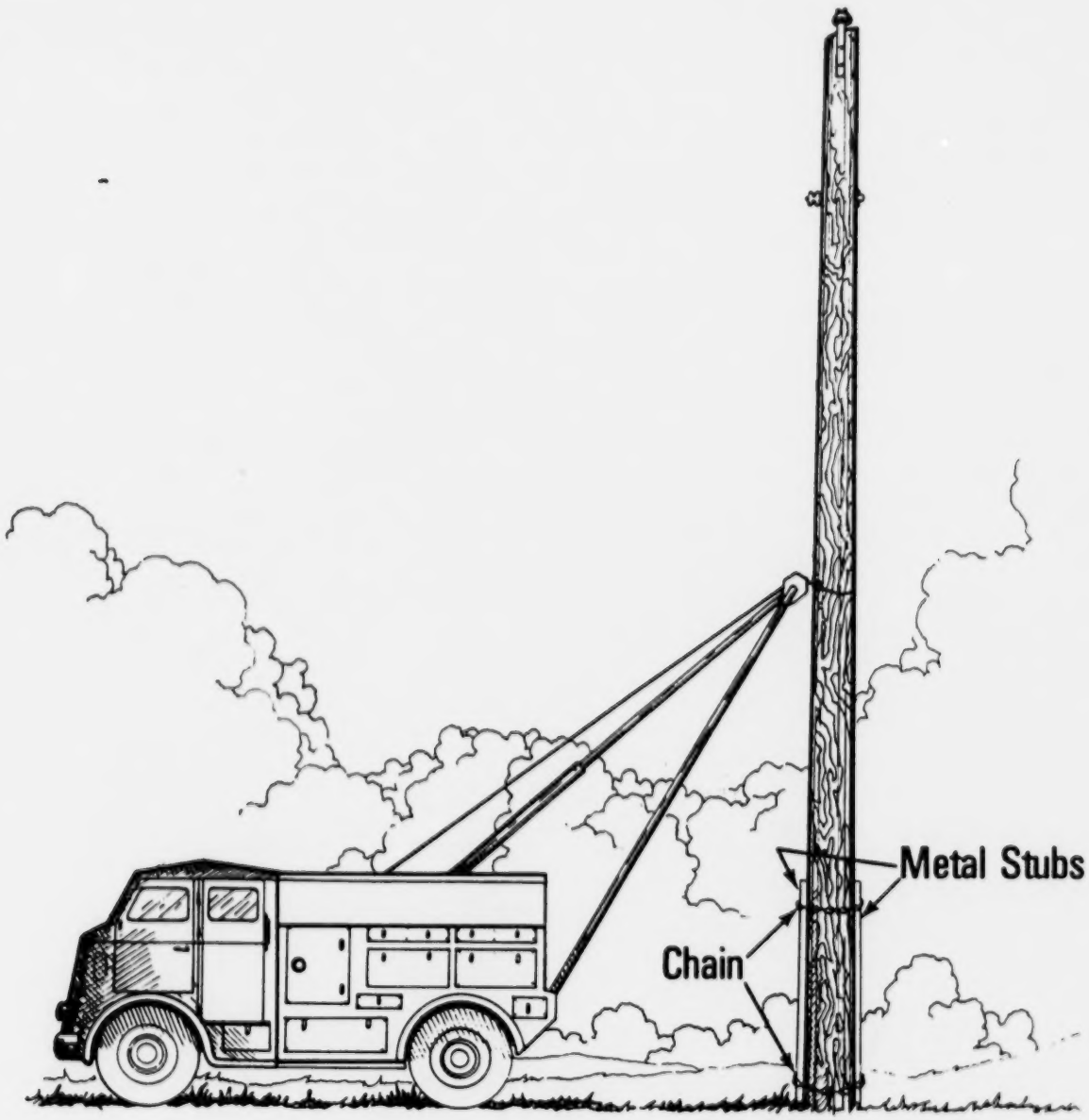
Supporting Unsafe Pole With A-Frame and Metal Stubs



TM 5

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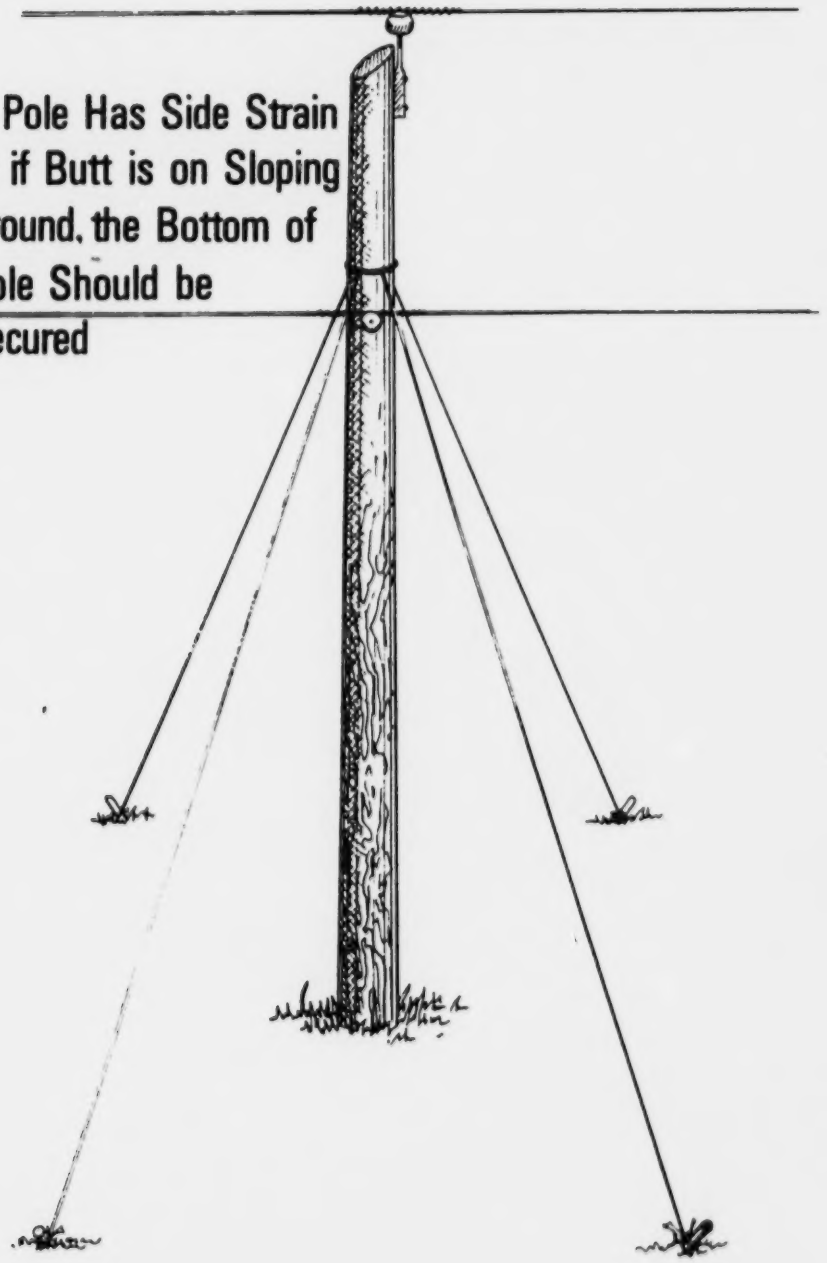
Supporting Unsafe Pole with Temporary Guys

Note: If Pole Has Side Strain or if Butt is on Sloping Ground, the Bottom of Pole Should be Secured



TM 6

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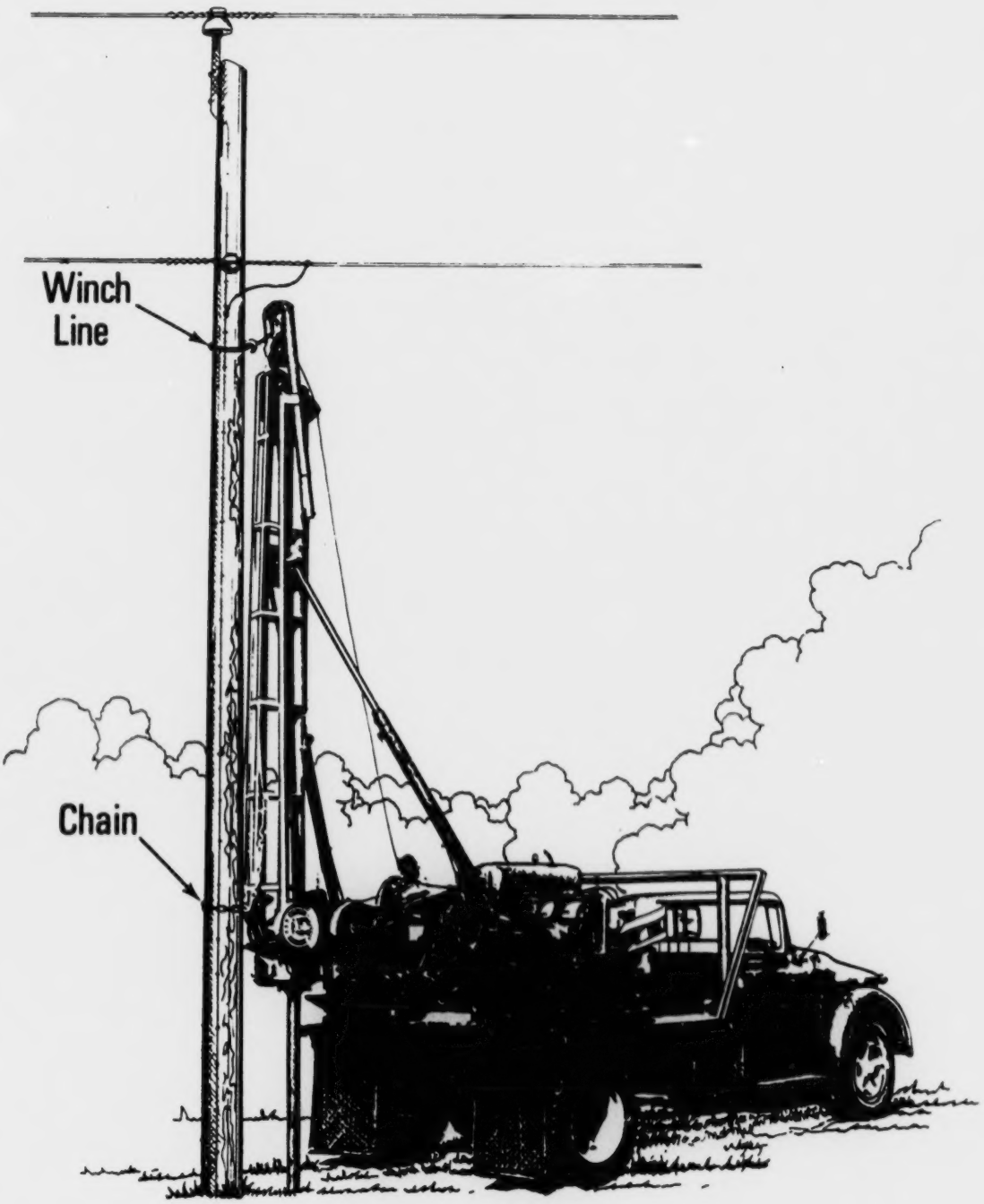
Supporting Pole with Digger Derrick



TM 7

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POLES
UNIT 1

TEST

NAME _____ SCORE _____

1. Match the terms associated with poles to the correct definitions. Place the correct number in the blank.

_____a.	Solution forced into pole to increase its life expectancy	1.	Split
_____b.	Concave side; side of greatest curvature between groundline and top of pole	2.	Sweep
_____c.	Portion of pole one foot above and two feet below groundline	3.	Shake
_____d.	Deviation from straightness in any five foot or shorter section which deviates more than one-half the diameter of the crooked section	4.	Face
_____e.	Deviation of a pole from straightness	5.	Preservative
_____f.	Separation of the wood along the grain	6.	Cross break
_____g.	Separation of the wood across the grain	7.	Groundline section
_____h.	Lengthwise separation of the wood cells through the full diameter of the pole	8.	Short crook
_____i.	Separation along the grain between the rings of annual growth	9.	Check

May be photocopied for student use.

TEST

2. List five types of preservatives used on poles.

a. _____

b. _____

c. _____

d. _____

e. _____

3. Match the types of preservatives used on poles with their code letters on the right. Place the correct number in the blank.

_____a.	Creosote	1.	N
_____b.	Creosote/coal tar solution	2.	X
_____c.	Creosote/petroleum solution	3.	S
_____d.	Copper naphthenate solution	4.	P
_____e.	Penta (pentachlorophenol) solution	5.	C
_____f.	Salt solution	6.	T

May be photocopied for student use.

TEST

4. Select from the table below the correct class for each pole having the given size and length.

	Length of Pole	Circumference at Top	Circumference 6' from Butt	Class
1.	45'	25"	40.5"	_____
2.	25'	20"	26"	_____
3.	30'	21"	29.5"	_____
4.	35'	24"	35"	_____

Class	1	2	3	4	5	6	7	9	10
Minimum Circumference at Top (Inches)	27	25	23	21	19	17	15	15	12

Length of Pole (Feet)	Groundline Distance from Butt (Feet)	Minimum Circumference at 6 Feet from Butt (Inches)								
20	4	31.0	29.0	27.0	25.0	23.0	21.0	19.5	17.5	14.0
25	5	33.5	31.5	29.5	27.5	25.5	23.0	21.5	19.5	15.0
30	5.5	36.5	34.0	32.0	29.5	27.5	25.0	23.5	20.5	
35	6	39.0	36.5	34.0	31.5	29.0	27.0	25.0		
40	6	41.0	38.5	36.0	33.5	31.0	28.5	26.5		
45	6.5	43.0	40.5	37.5	35.0	32.5	30.0	28.0		
50	7	45.0	42.0	39.0	36.5	34.0	31.5	29.0		
55	7.5	46.5	43.5	40.5	38.0	35.0	32.5			
60	8	48.0	45.0	42.0	39.0	36.0	33.5			
65	8.5	49.5	46.5	43.5	40.5	37.5				
70	9	51.0	48.0	45.0	41.5	38.5				
75	9.5	52.5	49.0	46.0	43.0					
80	10	54.0	50.5	47.0	44.0					
85	10.5	55.0	51.5	48.0						
90	11	56.0	53.0	49.0						
95	11	57.0	54.0	50.0						
100	11	58.5	55.0	51.0						
105	12	59.5	56.0	52.0						
110	12	60.5	57.0	53.0						
115	12	61.5	58.0							
120	12	62.5	59.0							
125	12	63.5	59.5							

May be photocopied for student use.

TEST

5. Select from the following list the precautions to observe when handling poles by placing an "X" in the blanks.

_____a. Roll pole away from yourself when moving it

_____b. Weigh pole before loading it

_____c. Do not use cant hook or pole carrying hook in groundline section of pole

_____d. Do not stand or walk on stacked poles

_____e. Move pole with cant hook or bar by working from the ends of pole

_____f. Use suitable equipment to lift pole

_____g. Do not drag pole

_____h. Attach sling or cable to pole by laying sling on ground and rolling pole onto sling

_____i. Do not drop pole from vehicle or pole rack

6. Calculate the weight of the following lengths and classes of poles from the table below.

	Length	Class	Weight
a.	40	6	_____
b.	30	5	_____
c.	35	4	_____
d.	35	5	_____
e.	30	7	_____

Length of Pole in Feet	Class						
	1	2	3	4	5	6	7
	Pounds						
25	990	811	674	573	491	422	344
30	1279	1082	921	784	660	550	454
35	1568	1343	1155	1004	862	743	646
40	1884	1623	1403	1219	1059	921	807
45	2223	1911	1664	1444	1274	1114	976
50	2585	2214	1925	1687	1494	1329	1169
55	2993	2567	2200	1934	1719	1563	
60	3451	2943	2512	2186	1953	1801	
65	4015	3341	2814	2457	2237		
70	4620	3781	3144	2732	2488		
75	5198	4235	3506	3021			
80	6400	5170	4240	3615			
85	7200	5745	4690				
90	8140	6405	5160				

May be photocopied for student use.

TEST

7. List four methods used to set poles.

   a. _____

   b. _____

   c. _____

   d. _____

8. State the correct procedure for checking a pole before climbing.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

   d. _____

   _____

9. Arrange in proper order the steps for pole inspection. Place a "1" before the first step, a "2" before the second step, and so on.

   _____a. Bore the pole with a 3/8" bit

   _____b. Read and record brand information

   _____c. Check for broken insulators

   _____d. Sound the pole above ground

   _____e. Sound the pole below ground

   _____f. Excavate the pole to a depth of 18"

10. List three methods used to support unsafe poles for climbing.

    a. _____

    b. _____

    c. _____

May be photocopied for student use.

TEST

11. State the correct method for storing poles.

_____

_____

12. Evaluated on Assignment Sheet 1.

13. Evaluated on Assignment Sheet 2.

May be photocopied for student use.

CONDUCTORS
UNIT 2

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information and job sheets.
   - Make transparencies.
   - Discuss unit and specific objectives.
   - Discuss information sheet.
   - Demonstrate the use and adjustment of crimping tool.
   - Show student ACSR and copperweld conductors of various sizes.
   - Demonstrate and discuss the procedures outlined on the job sheets.
   - Give test.

2. Unit References:

   - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 8th ed. New York: McGraw-Hill Book Co., 1992.
   - *National Electrical Safety Code*, 1993 ed. New York: The Institute of electrical and Electronics Engineers, Inc., 1993.
   - *Power Line Technician*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

CONDUCTORS
UNIT 2

ANSWERS TO TEST

1.

a.	10	g.	13	m.	7
b.	12	h.	3	n.	1
c.	8	i.	2	o.	14
d.	6	j.	4	p.	16
e.	5	k.	11		
f.	15	l.	9		

2. (NOTE: Any three of the following answers are acceptable.)

   a. Preformed armor rod

   b. Clip type armor rod

   c. Performed conductor tie

   d. Armor tape

3.

a.	5	e.	8
b.	6	f.	3
c.	2	g.	7
d.	4	h.	1

4. a. 4

   b. 3

   c. 2

   d. 1

5. a. Solid

   b. Stranded

ANSWERS TO TEST

6. a. Tie off end of conductor and move reel along line route
   b. Set up reel and pull conductor through structures or along the ground
   c. Set up anchored reel with braking system and pull conductor under controlled tension through structures

7. a. ACSR conductor top groove double insulator double tie
   b. Copper conductor side groove
   c. ACSR conductor top groove double tie
   d. Copper conductor top groove
   e. ACSR conductor side groove preformed tie
   f. ACSR conductor side groove double insulator hot line tie
   g. ACSR conductor top groove preformed tie
   h. Copper conductor top groove hot line tie
   i. ACSR conductor side groove tie
   j. Copper conductor side groove hot line tie
   k. ACSR conductor side groove double insulator double tie
   l. ACSR conductor top groove double insulator hot line tie
   m. Dead end tie
   n. Top tie

8. a. 4
   b. 1, 2, 3
   c. 5

9. a. 16 feet
   b. 12 feet
   c. 16 feet
   d. 12 feet
   e. 24 feet

ANSWERS TO TEST

10. a. 18.5 feet
    b. 14.5 feet
    c. 18.5 feet
    d. 14.5 feet
    e. 26.5 feet

11. a. 2
    b. 1
    c. 1
    d. 2
    e. 1
    f. 2
    g. 2
    h. 1
    i. 1
    j. 2
    k. 2
    l. 1
    m. 2
    n. 2

12. a. 2
    b. 1
    c. 1
    d. 2
    e. 2
    f. 2

13. Evaluated on Job Sheet 1.

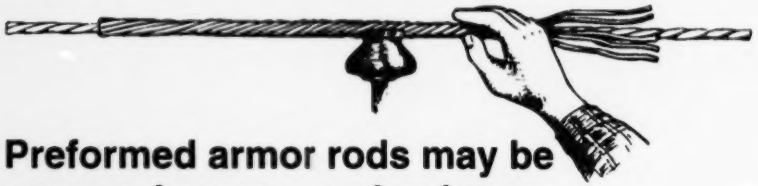
14. Evaluated on Job Sheet 2.

15. Evaluated on Job Sheet 3.

16. Evaluated on Job Sheet 4.

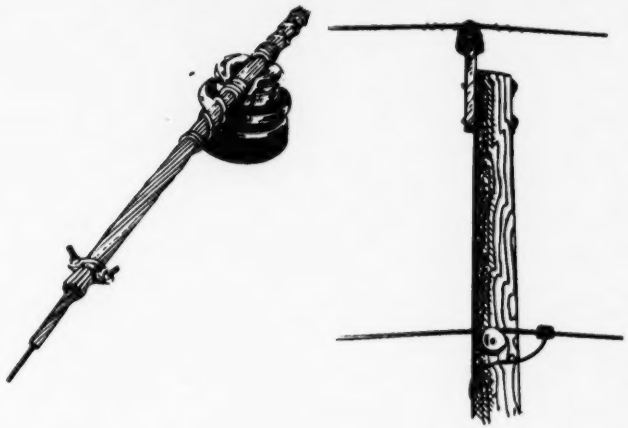
Methods To Protect Line Conductor At Supports

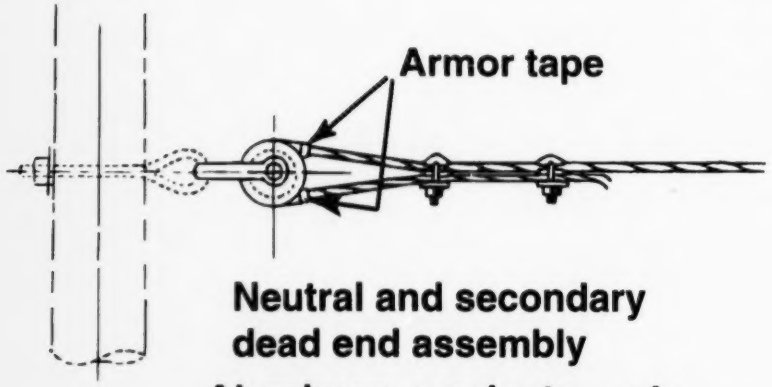
Preformed Armor Rod



Preformed armor rods may be copper, bronze, or aluminum rods are used only on aluminum conductor

Clip Type Armor Rod

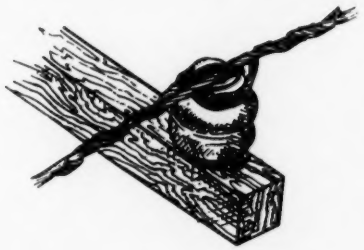




Neutral and secondary dead end assembly

Aluminum conductor only

Preformed Tie



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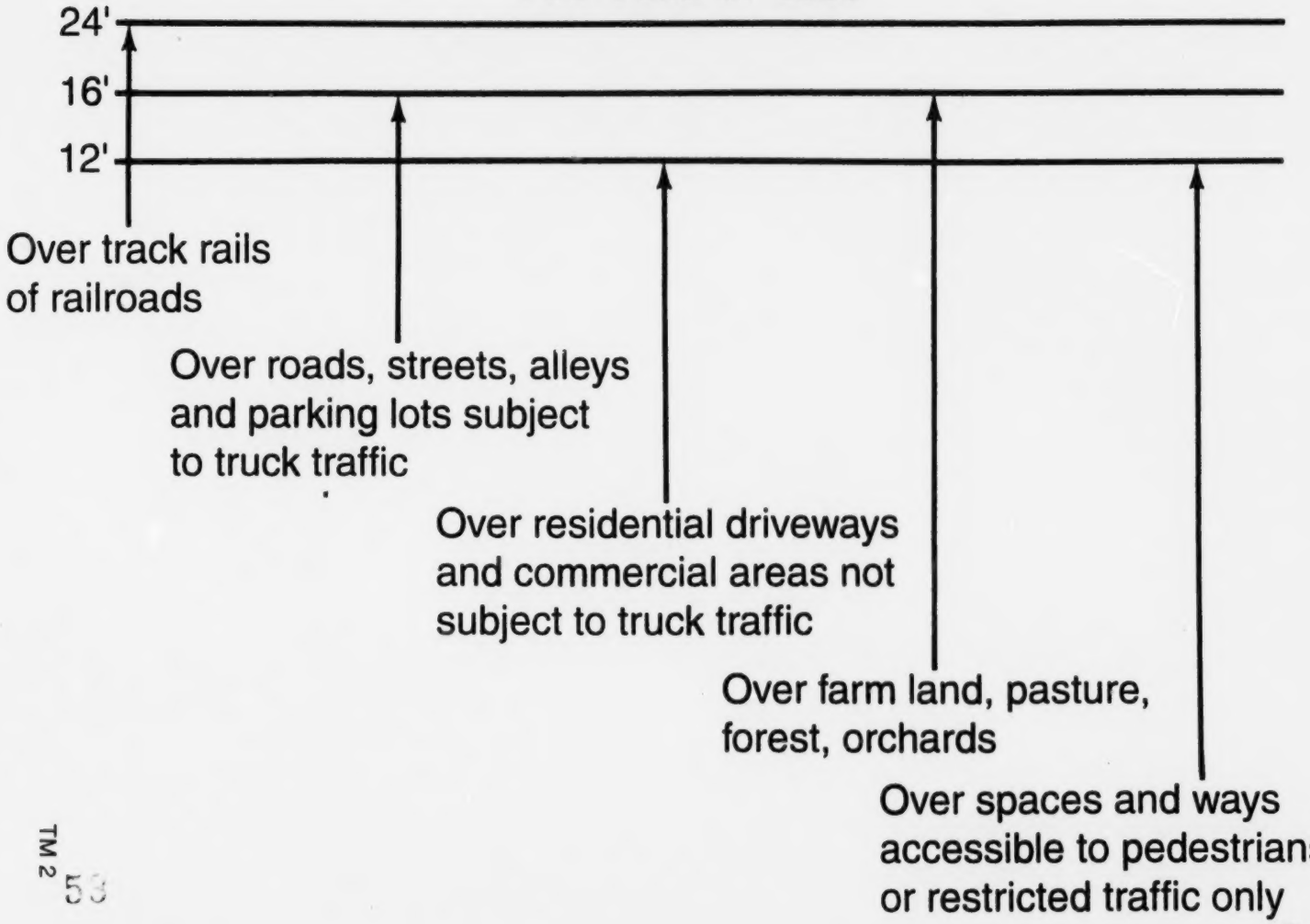
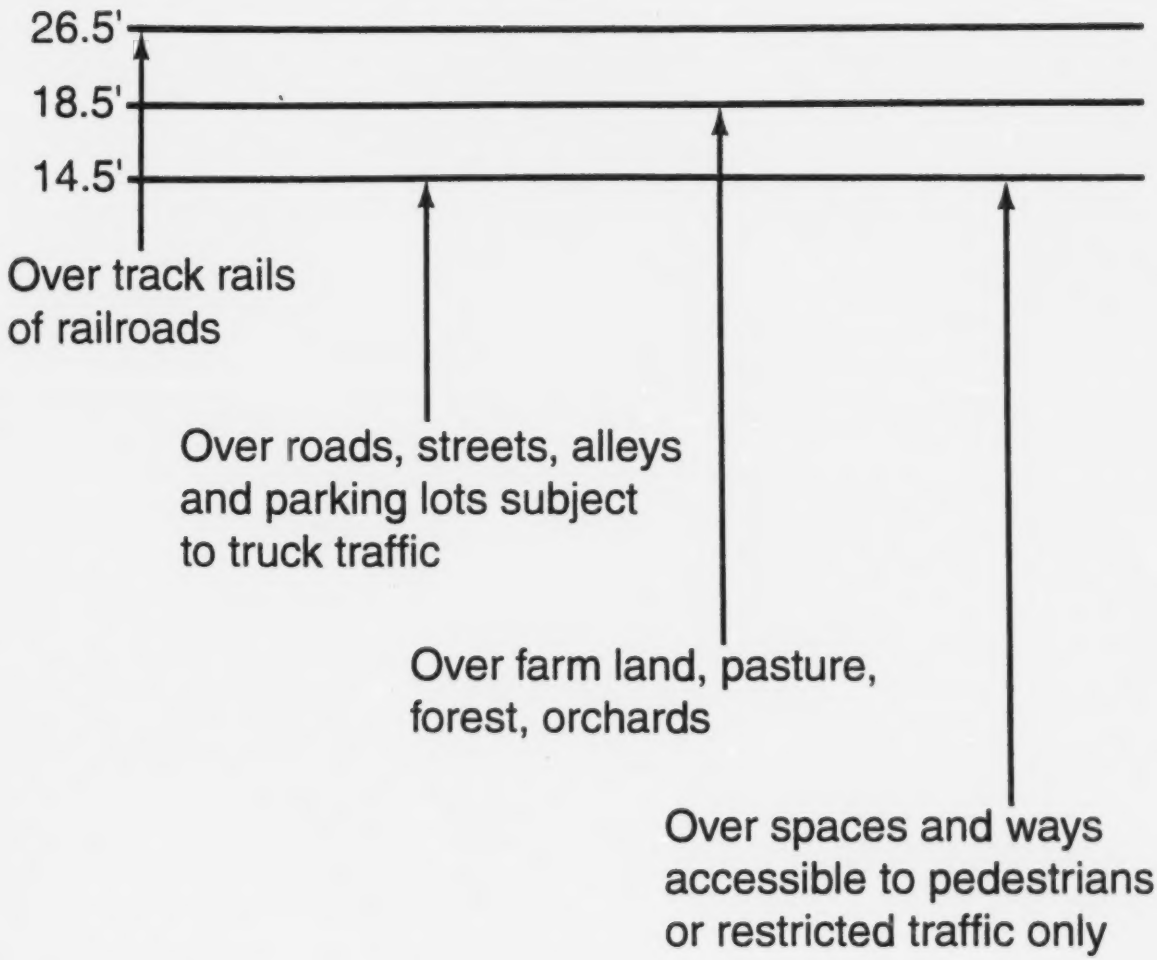
Clearance from Ground for Conductors

750 Volts or Less


24'
16'
12'
Over track rails of railroads
Over roads, streets, alleys and parking lots subject to truck traffic
Over residential driveways and commercial areas not subject to truck traffic
Over farm land, pasture, forest, orchards
Over spaces and ways accessible to pedestrians or restricted traffic only

May be photocopied for student use.

Clearance from Ground for Conductors Over 750 Volts to 22,000 Volts


26.5'
18.5'
14.5'
Over track rails of railroads
Over roads, streets, alleys and parking lots subject to truck traffic
Over farm land, pasture, forest, orchards
Over spaces and ways accessible to pedestrians or restricted traffic only

TM 3

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CONDUCTORS
UNIT 2

TEST

NAME _____ SCORE _____

1. Match terms associated with line conductors to the correct definitions.

_____a.	Aluminum conductor steel reinforced	1.	Armor tape
_____b.	Copperweld copper conductor	2.	Kcmil
_____c.	American wire gauge	3.	Circular mil
_____d.	To heat and let cool slowly to soften	4.	Static wire
_____e.	Annealed wire	5.	Soft-drawn wire
_____f.	Steel wire with a welded coating of aluminum	6.	Anneal
		7.	Copperweld
_____g.	Wire which has been tempered for strength	8.	AWG
_____h.	Area of a circle which is one-thousandth of an inch in diameter	9.	Kilovolt (kV)
		10.	ACSR
_____i.	One thousand circular mils	11.	Weatherproofing
_____j.	Steel conductor strung above transmission lines for a ground wire	12.	CWC
_____k.	Coating of neoprene or of braided cotton saturated with an asphalt compound	13.	Hard-drawn wire
		14.	Crimping tool
_____l.	Unit of measure of electromotive force equal to one thousand volts	15.	Alumoweld wire
_____m.	Steel core conductor with a welded coating of copper	16.	Brown and Sharpe
_____n.	Flat aluminum ribbon one-fourth inch wide		
_____o.	Tool used to join conductor with a sleeve		
_____p.	Previous standard, now know as AWG		

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TEST

2. List three methods used to protect line conductor at supports.

   a. _____

   b. _____

   c. _____

3. Arrange in order the steps to follow when joining ACSR conductors. Place a "1" before the first step, a "2" before the second step, and so on.

   _____a. Slide conductor sleeve onto conductor

   _____b. Install and crimp core sleeve

   _____c. Select proper crimping tool

   _____d. Clean conductor with conductor brush

   _____e. Crimp conductor sleeve from center of sleeve outward

   _____f. Remove aluminum strands from steel core the distance recommended by splice manufacturer

   _____g. Slide center of conductor sleeve to center of core sleeve

   _____h. Select proper sleeve for wire size

4. Arrange in order the steps to follow when joining CWC conductors. Place a "1" before the first step, a "2" before the second step, and so on.

   _____a. Install sleeve and crimp from center of sleeve outward

   _____b. Clean conductor with conductor brush

   _____c. Select proper crimping tool

   _____d. Select proper sleeve for wire size

5. List two classes of conductors.

   a. _____

   b. _____

May be photocopied for student use.

TEST

6. List three methods of reeling out conductor.

a. _____

_____

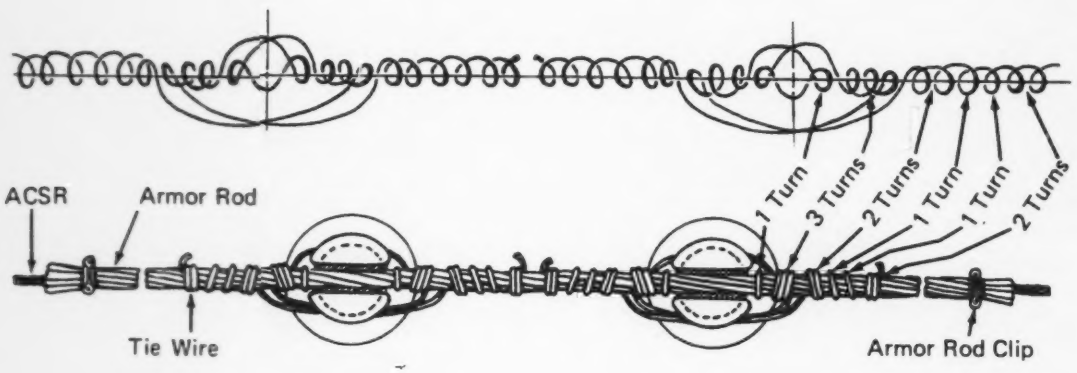
b. _____

_____

c. _____

_____

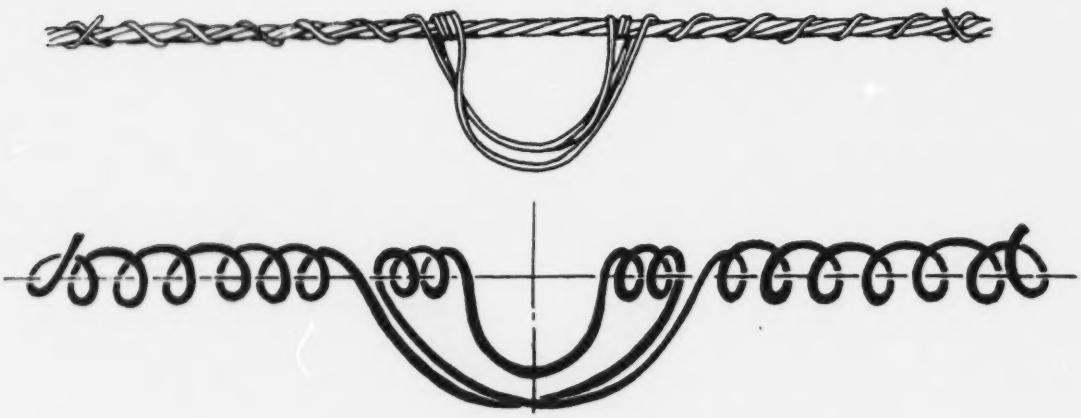
7. Identify the following conductor ties.



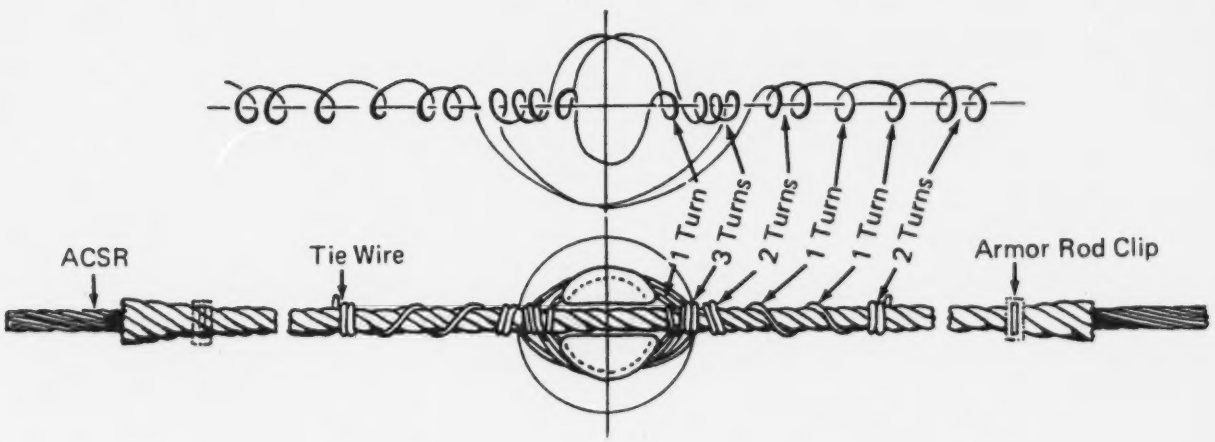
a. _____

May be photocopied for student use.

TEST



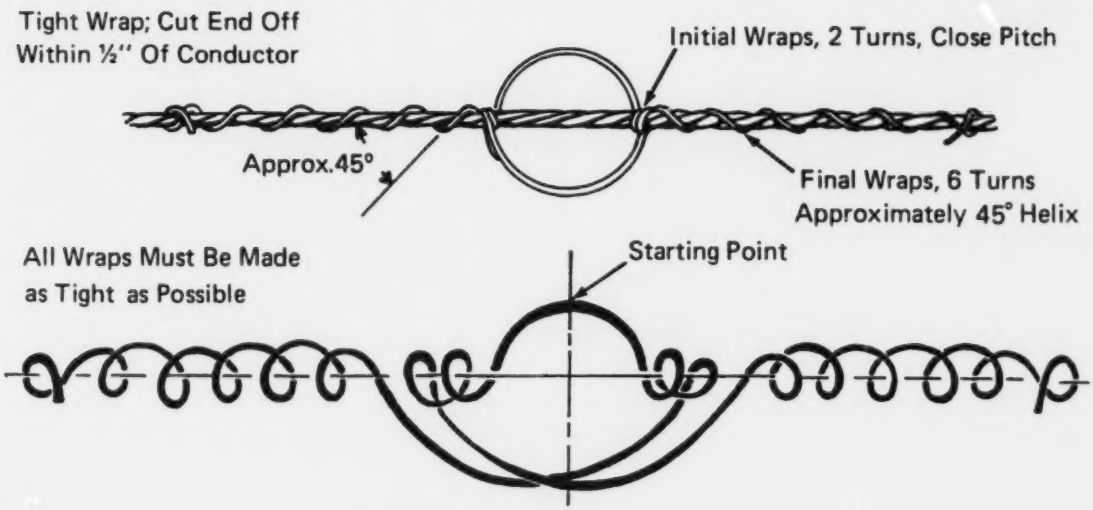
b. _____



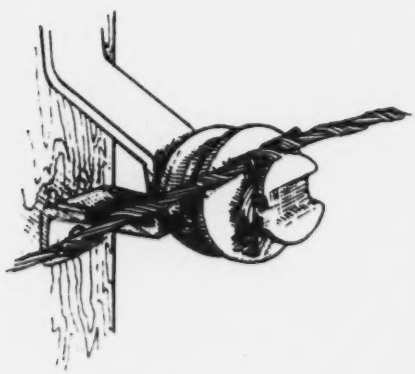
c. _____

May be photocopied for student use.

TEST



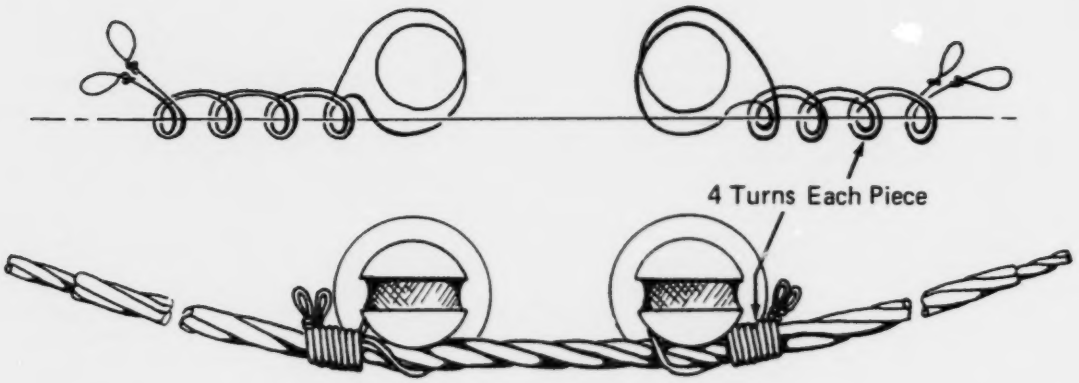
d. _____



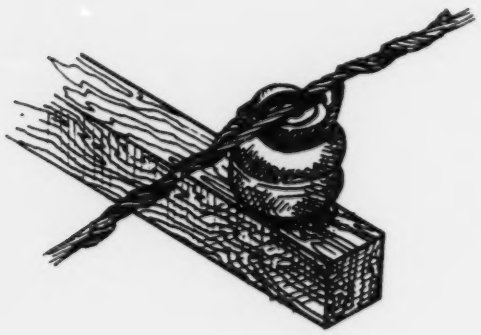
e. _____

May be photocopied for student use.

TEST



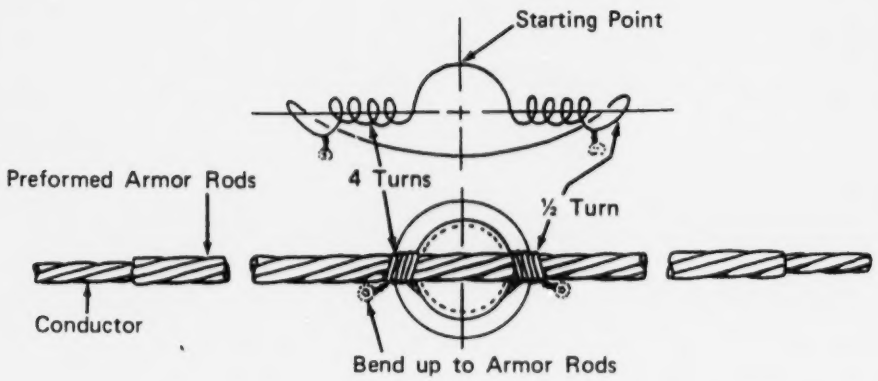
f. _____



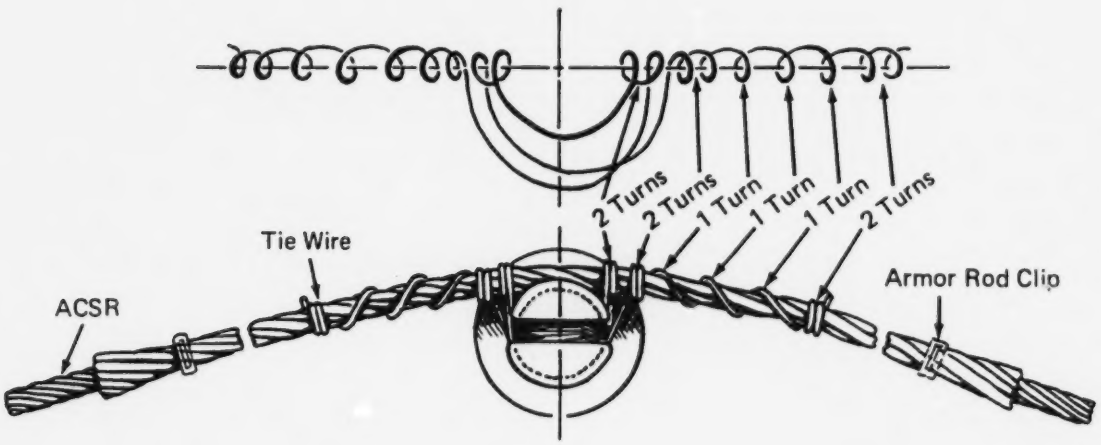
g. _____

May be photocopied for student use.

TEST



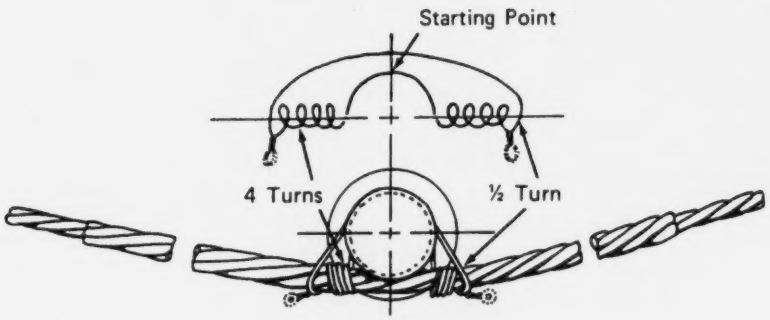
h. _____



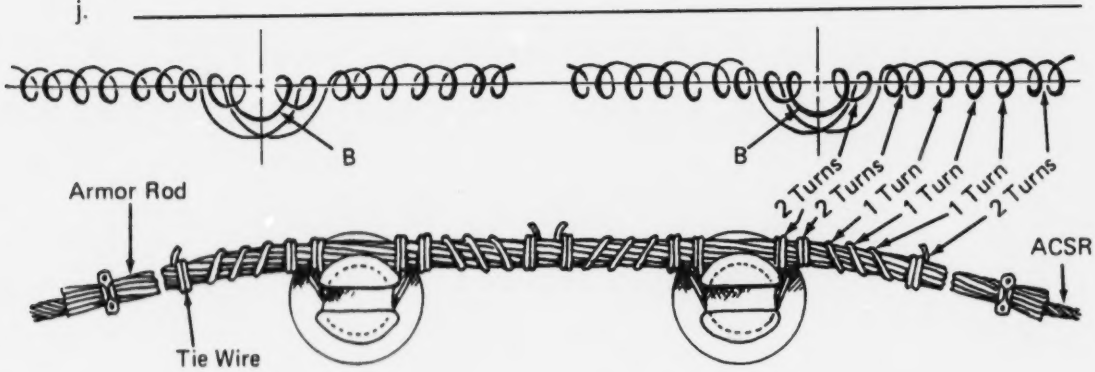
i. _____

May be photocopied for student use.

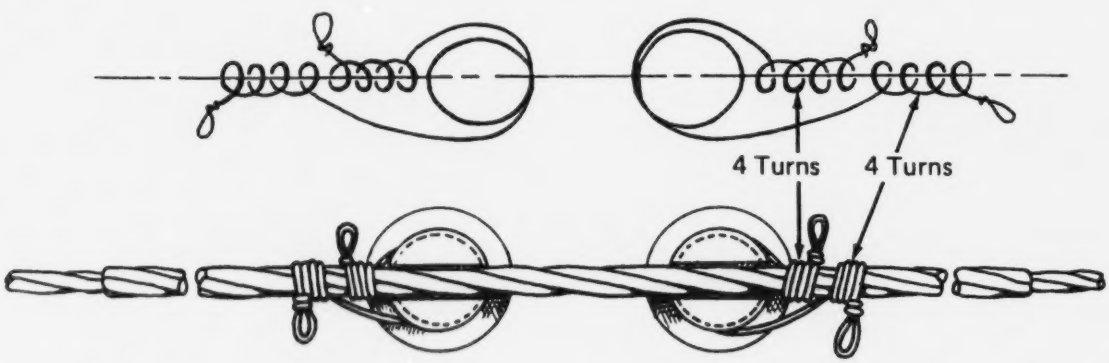
TEST



j. _____



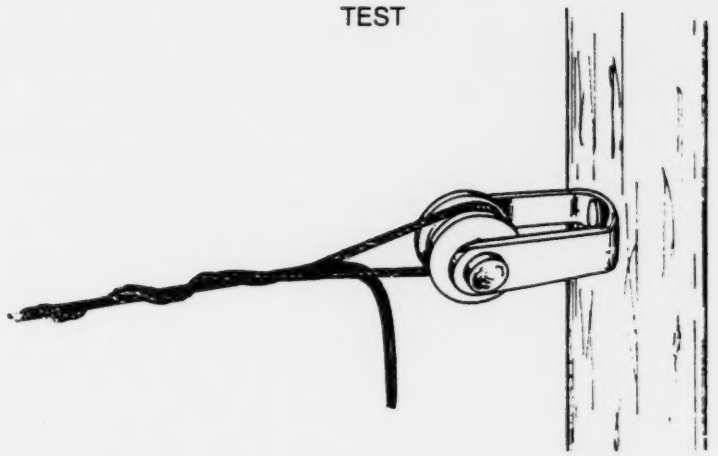
k. _____



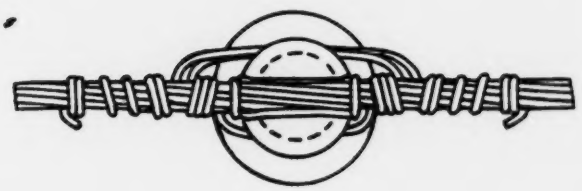
l. _____

May be photocopied for student use.

TEST



m. _____



n. _____

May be photocopied for student use.

TEST

8. Match the types of conductors on the right to the specific use.

_____a. Pole ground, tie wire, and jumper	1. ACSR
_____b. Primary and secondary	2. Copperweld copper
_____c. Secondary and service	3. Hard-drawn copper
	4. Soft-drawn copper
	5. Weatherproof

9. State the ground clearance for conductors carrying 750 volts or less over the following locations.

   a. Over commercial parking lots and agricultural areas not subject to truck traffic

   b. Over sidewalks or platforms from which the conductor may be reached

   c. Over public streets, alleys, and driveways other than residential which are subject to truck traffic and roofs accessible to vehicular traffic

   d. Over residential driveways and commercial areas not subject to truck traffic

   e. Over track rails of railroads

10. State the ground clearance for conductors carrying over 750 volts to 22,000 volts over the following locations.

   a. Over commercial parking lots and agricultural areas not subject to truck traffic

   b. Over sidewalks or platforms from which the conductor may be reached

   c. Over public streets, alleys, and driveways other than residential which are subject to truck traffic and roofs accessible to vehicular traffic

   d. Over residential driveways and commercial areas not subject to truck traffic

May be photocopied for student use.

TEST

e. Over track rails of railroads

11. Match the approximate current-carrying capacities on the right to the correct ACSR conductor size.

_____a. #4	1.	130
	2.	140
_____b. #2	1.	175
	2.	165
_____c. #1	1.	200
	2.	210
_____d. #1/0	1.	240
	2.	230
_____e. #2/0	1.	265
	2.	275
_____f. #3/0	1.	340
	2.	310
_____g. #4/0	1.	300
	2.	350
_____h. 266.8 Kcmil	1.	410-440
	2.	310-340
_____i. 336.4 Kcmil	1.	500-515
	2.	510-525
_____j. 397.5 Kcmil	1.	550-595
	2.	555-575
_____k. 477 Kcmil	1.	560
	2.	625
_____l. 556.5 Kcmil	1.	690-710
	2.	700-725
_____m. 605 Kcmil	1.	680-715
	2.	740-760
_____n. 636 Kcmil	1.	875-900
	2.	745-775

May be photocopied for student use.

TEST

12. Match the current-carrying capacities on the right to the correct copperweld copper conductor size.

_____a. 8A	1.	90
	2.	100
_____b. 6A	1.	140
	2.	120
_____c. 4A	1.	180
	2.	160
_____d. 2F	1.	250
	2.	230
_____e. 1/0F	1.	330
	2.	310
_____f. 3/0F	1.	460
	2.	410

13. Evaluated on Job Sheet 1.

14. Evaluated on Job Sheet 2.

15. Evaluated on Job Sheet 3.

16. Evaluated on Job Sheet 4.

May be photocopied for student use.

GROUNDING AND CONNECTING
UNIT 3

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information sheet.
   - Discuss unit and specific objectives.
   - Discuss information sheet.
   - Give test.

2. Unit references:

   - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 8th ed. New York: McGraw-Hill Book Co., 1992.
   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

GROUNDING AND CONNECTING
UNIT 3

ANSWERS TO TEST

1.

a.	13	f.	6	k.	2
b.	5	g.	10	l.	4
c.	14	h.	7	m.	3
d.	11	i.	8	n.	12
e.	9	j.	1		

2. a. Prevent injury to persons
   b. Protect lines and equipment from lightning
   c. Drain off unwanted voltage and current

3. (NOTE: Any three of the following methods are acceptable.)
   a. Driven rod
   b. Screw-in rod
   c. Coil or plate fastened to bottom of pole
   d. Buried metal mat

4. a, c, d, f

5. a, b, c, d, f, g, i, j, k, l, m, n, o, p, q

6. a. Disconnect line jumper and fasten it back on itself
   b. Test line for potential
   c. Attach one end of grounding cable to neutral
   d. Attach other end of grounding cable to phase wire
   e. Attach hold card
   f. Install grounds within sight on both sides of work area on all conductors

ANSWERS TO TEST

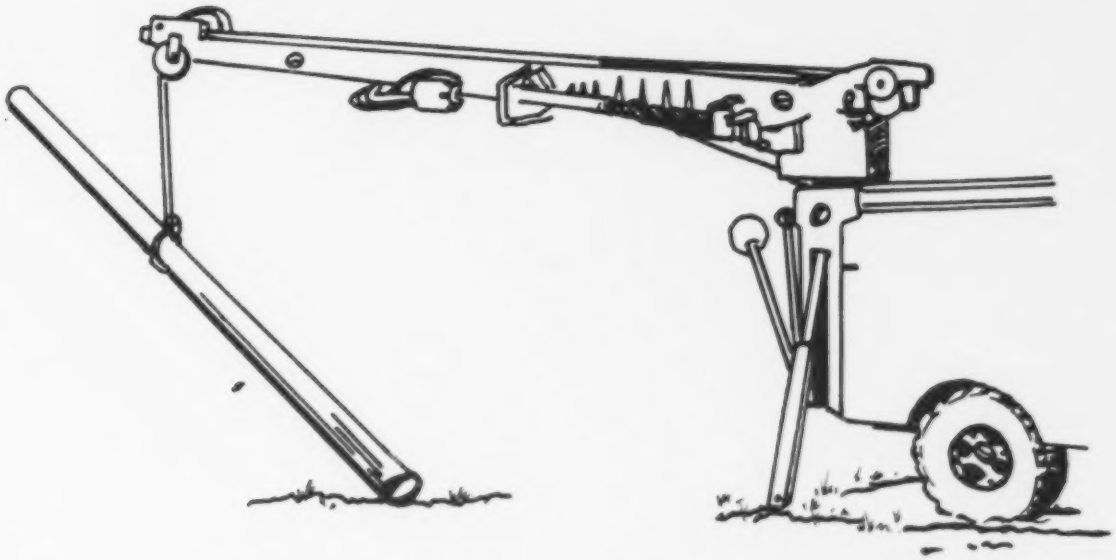
7. a. 5 d. 4
   b. 2 e. 3
   c. 1

8. a. 4 d. 1
   b. 3 e. 2
   c. 5

9. a. Open switch
   b. Check switch blades visually to see that they are open
   c. Lock switch open
   d. Connect ground cable to driven or system neutral or screw-in ground if accessible
   e. Attach ground cable to center phase wire on load side of switch
   f. Connect short ground cables to center grounded phase and to both outside phase wires

10. a. Connector sized to conductor being connected
    b. Clean conductor
    c. Proper connector for type of conductor
    d. Inhibitor applied to conductor

Method of Grounding Truck While Setting or Removing Pole In Energized Line



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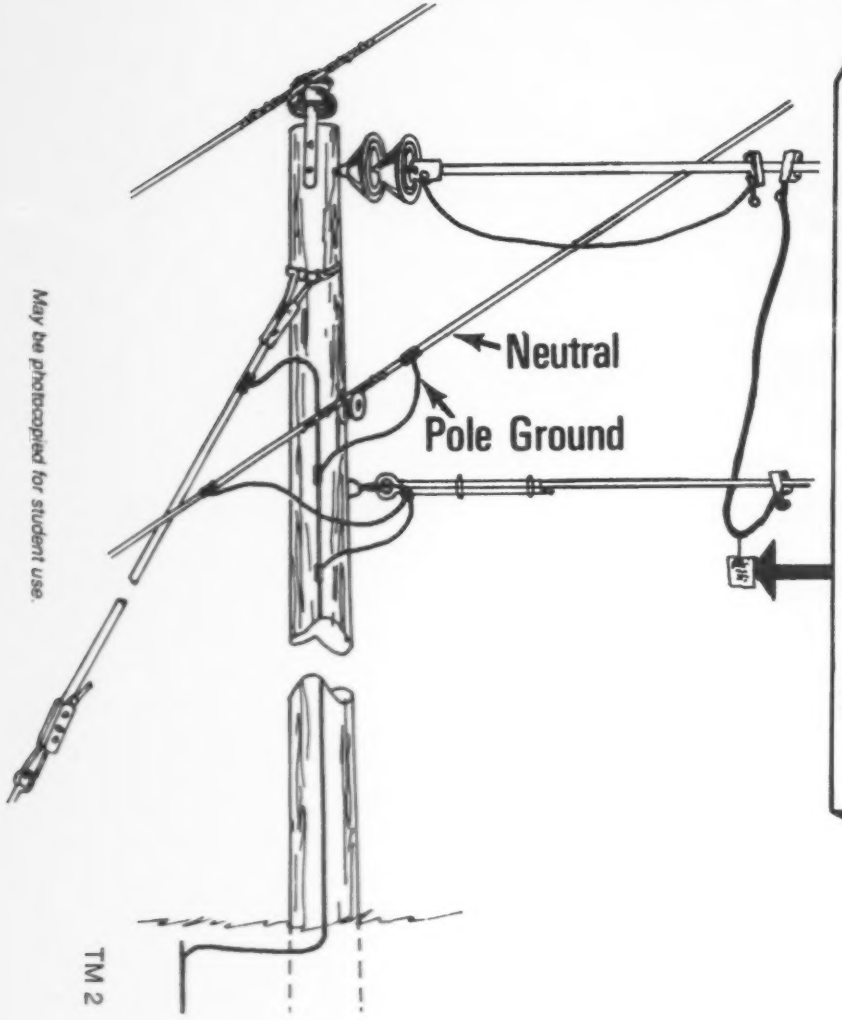
Disconnecting and Grounding a Tap Line



May be photocopied for student use.

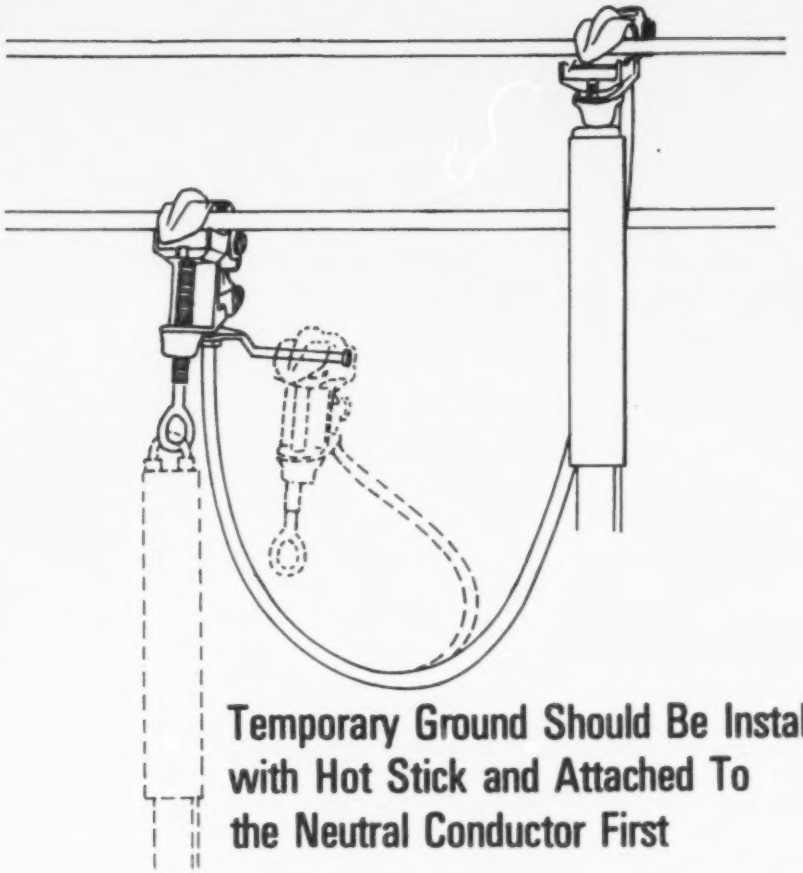
DANGER	DANGER
SWITCH ORDERED OUT BY John Doe DATE 1-16-95 TIME 1:30 P.M. SWITCH ORDERED IN BY DATE 1-16-95 TIME 2:00 P.M. SIGNED BY John Doe DATE 1-16-95	DO NOT REMOVE THIS TAG LEAVE THIS SWITCH OUT MEN WORKING ON LINE SEE OTHER SIDE

Hold Card

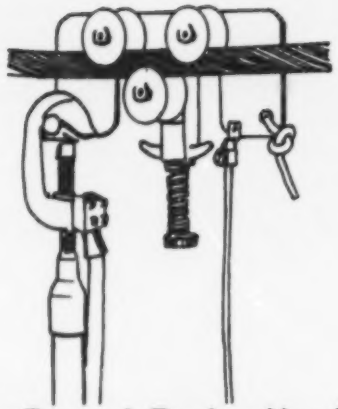
PLT C - 3 - 7

TM 2

Temporary Grounds



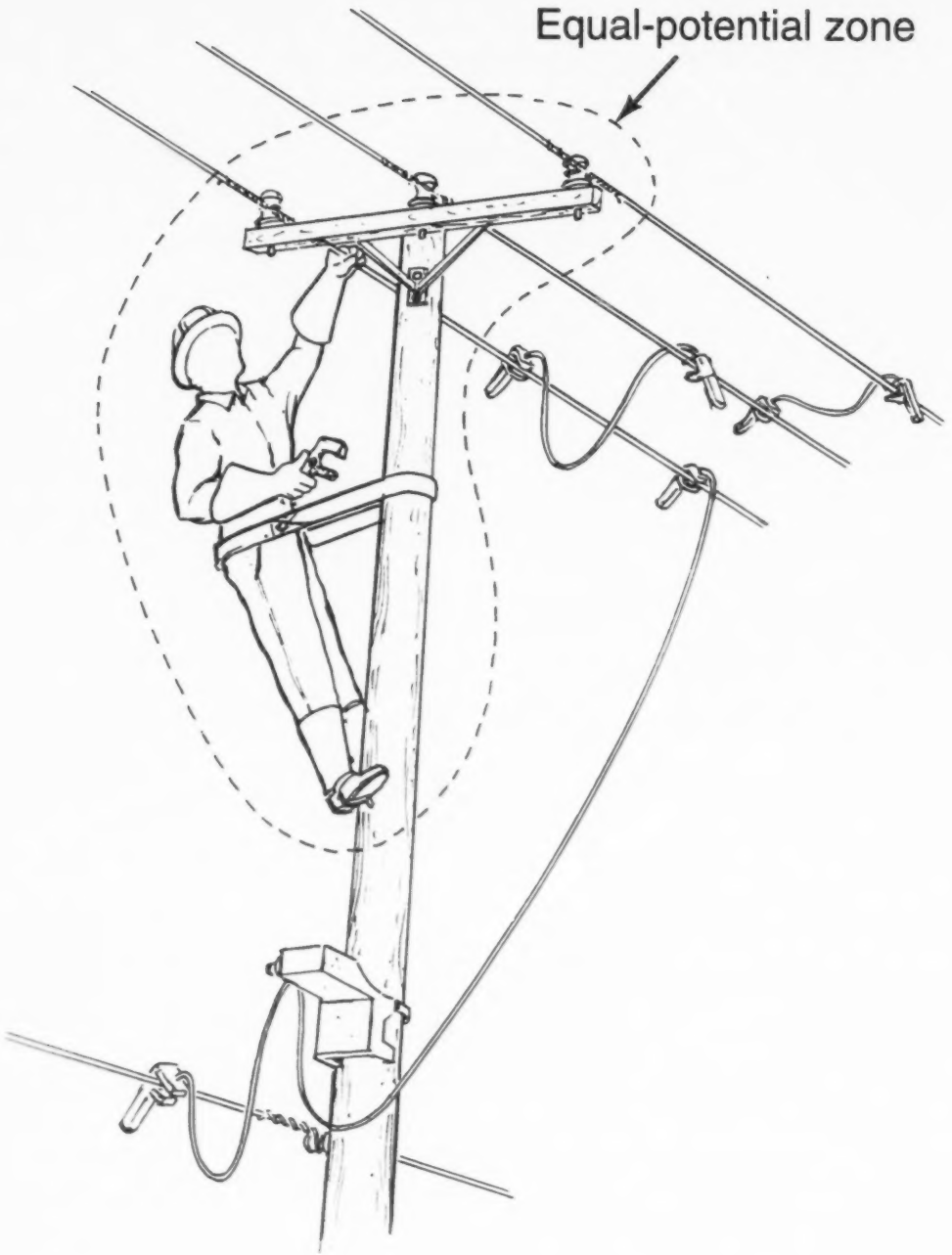
Temporary Ground Should Be Installed with Hot Stick and Attached To the Neutral Conductor First



Running Ground Device Used On Moving Conductor While Stringing and Sagging Is Being Done

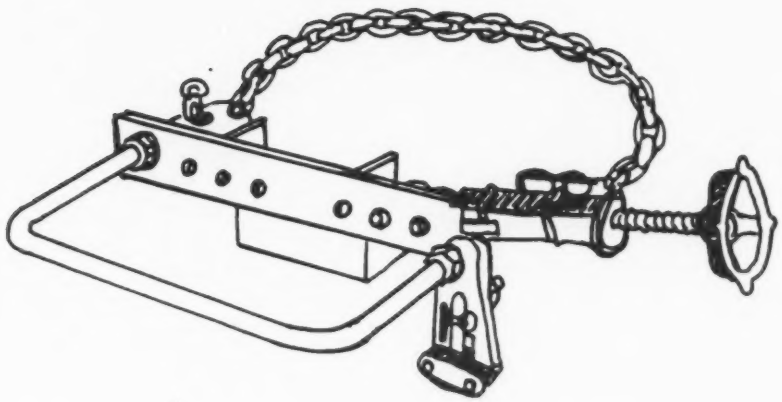
May be photocopied for student use.

Equal-Potential Grounding



May be photocopied for student use.

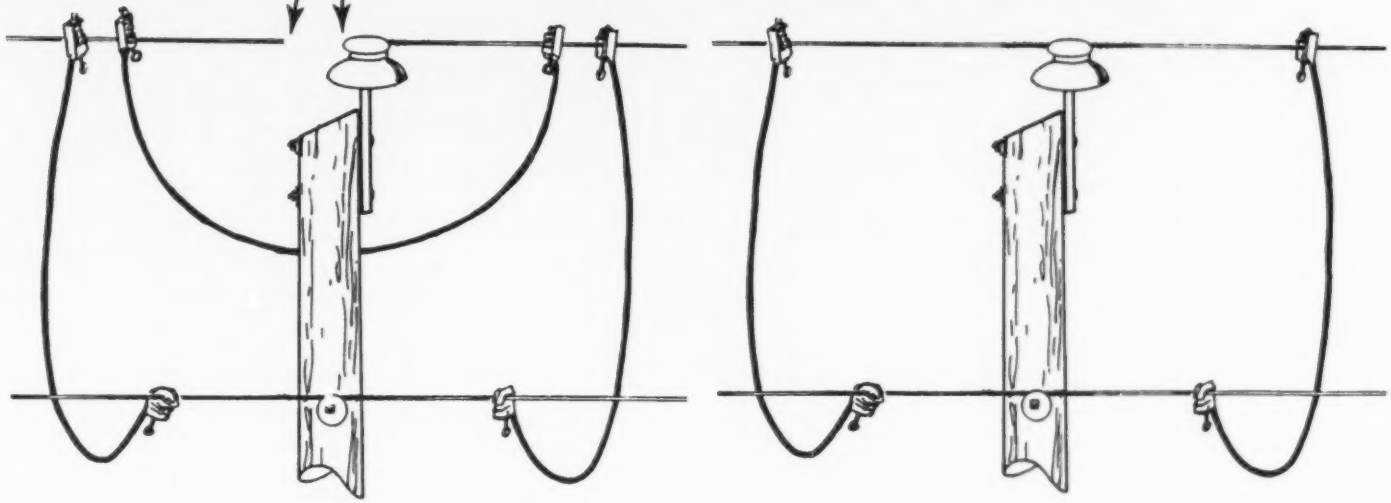
Cluster Support Bracket



May be photocopied for student use.

Protective Grounds at Work Area

Use mechanical jumper plus hoists and grips, do not be caught between open ends without jumper.

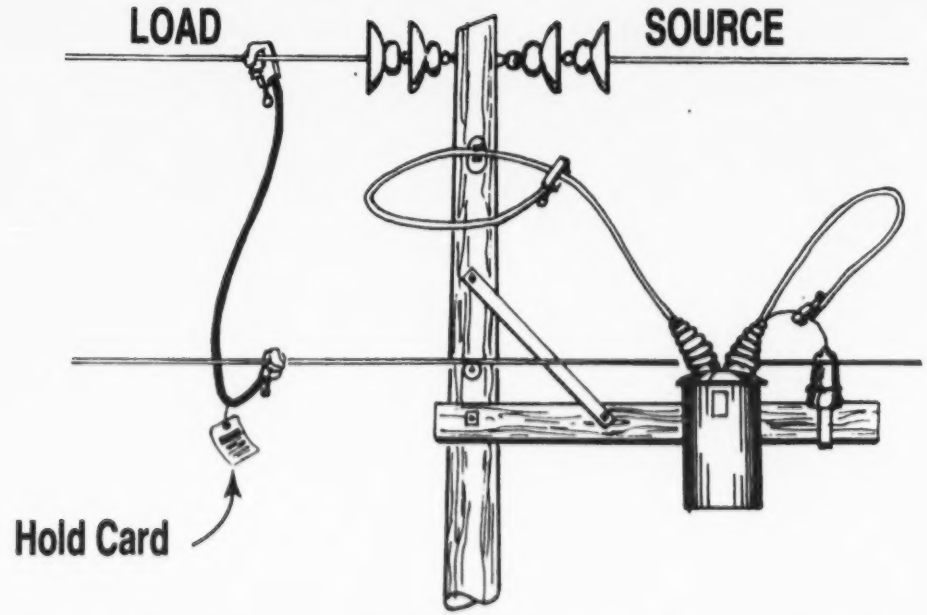


Wire Repair

Insulator Replacement

May be photocopied for student use.

Protective Grounds At Work Area



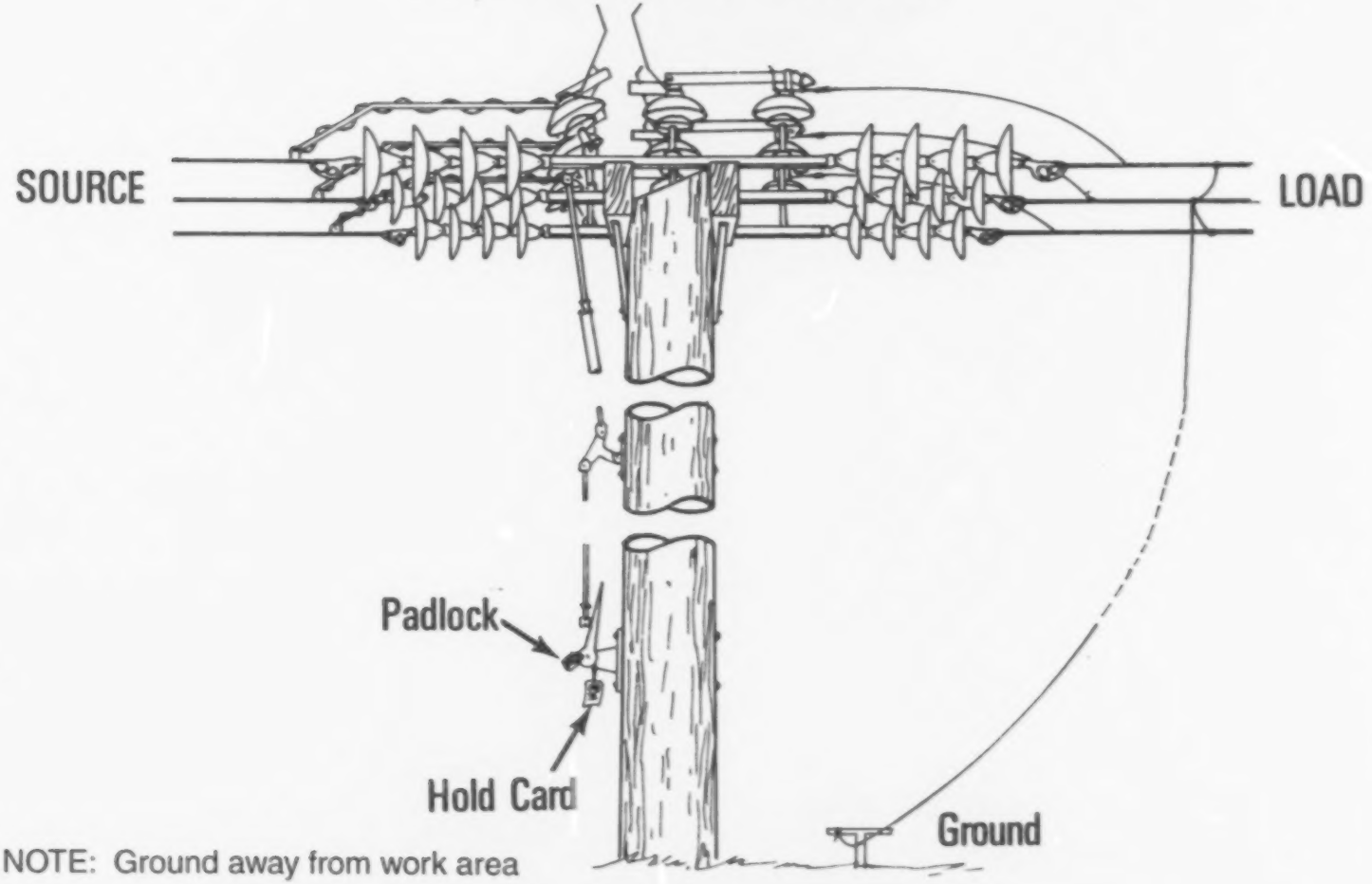
Disconnecting and grounding at recloser or sectionalizer.

May be photocopied for student use.

Disconnecting and Grounding Multi-Phase Vertical Corners

May be photocopied for student use

Disconnecting and Grounding an Air-Break Switch



NOTE: Ground away from work area

May be photocopied for student use

GROUNDING AND CONNECTING
UNIT 3

TEST

NAME _____ SCORE _____

1. Match terms commonly associated with grounds and connectors on the right to the correct definitions. (Definitions are continued on the following page.)

_____a.	Installing a driven ground or connecting equipment to an existing ground	1.	Cluster bracket
_____b.	Connecting the line neutral to the pole ground	2.	Ground resistance
_____c.	A cluster block on a wood pole structure below the work area connected to the grounding conductor	3.	Hold card
_____d.	Connecting the tank, frame, or housing of equipment to a ground	4.	Temporary ground
_____e.	Ground installed to protect persons which may come in contact with equipment	5.	Line grounding
_____f.	Ground on a primary circuit which is irregular	6.	"Swinging" ground
_____g.	Ground which has poor contact or high resistance to earth	7.	"Solid" ground
_____h.	Ground which has little resistance between the circuit and earth	8.	Inhibitor
_____i.	Substance used on conductors to prevent oxidation or corrosion and to help make a better connection	9.	Protective ground
_____j.	Apparatus used to hang grounding sets on the pole to facilitate lifting clamps, one at a time to the conductors	10.	"Light" ground
_____k.	Resistance caused by poor connection or poor soil condition	11.	Equipment grounding
_____l.	Ground installed by a line technician for personal protection	12.	Running ground
		13.	Mobile equipment grounding
		14.	Equal-potential grounding

May be photocopied for student use.

TEST

_____m. Tag placed at disconnect point to prevent someone else from re-energizing line

_____n. Ground used on conductor being pulled

2. State three purposes of grounding.

a. _____

b. _____

c. _____

3. List three methods of grounding.

a. _____

b. _____

c. _____

4. Select from the following list those elements necessary for good grounding.

_____a. Contact with moist soil

_____b. High impedance to ground

_____c. Metal construction that resists corrosion

_____d. Low resistance to earth

_____e. Small conductor with high resistance

_____f. Capacity for maximum current surges

5. Select from the following list equipment which must be grounded.

_____a. Metal conduit

_____b. Metering equipment

_____c. Cable sheath

_____d. Hand-operated switch gear

_____e. Plastic conduit

_____f. Current and potential transformers

May be photocopied for student use.

TEST

_____g. Metal pole

_____h. Wooden crossarm

_____i. Guy wire

_____j. Transformer tank

_____k. Motor casing

_____l. Capacitor rack

_____m. Transformer platform

_____n. Voltage regulator tank

_____o. Lightning arrester

_____p. Switch box

_____q. Mobile equipment working near energized lines

6. State the correct procedure for installing temporary protective grounds.

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

_____

f. _____

_____

May be photocopied for student use.

TEST

7. Arrange in correct order the steps to follow when disconnecting and grounding at sectionalizer or recloser station. Place a "1" in front of the first step a "2" in front of the second step and so on.

_____a. Attach hold card

_____b. Remove source side jumper and fasten it back on itself

_____c. Move operating handle to Off position with hot stick

_____d. Attach ground cable to neutral on load side and then to phase wire on load side

_____e. Remove load side jumper and fasten it back on itself or on the neutral

8. Arrange in order the steps to follow when disconnecting and grounding at multi-phase vertical corner. Place a "1" in front of the first step, a "2" in front of the second step and so on.

_____a. Attach ground cable to center phase and connect to top phase

_____b. Attach ground cable to bottom phase and connect to center phase

_____c. Attach hold card

_____d. Disconnect all phases, starting with the bottom phase and going upward, and fasten each jumper back on its own line

_____e. Attach ground cable to neutral wire and then to bottom phase wire

9. State the procedure for installing temporary protective grounds at air-break switch on a transmission line.

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

May be photocopied for student use.

TEST

e. _____

_____

f. _____

_____

10. List four elements of a good connection.

a. _____

b. _____

c. _____

d. _____

May be photocopied for student use.

GENERATORS AND BATTERIES
UNIT 4

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information and assignment sheets.
   - Make Transparencies.
   - Discuss unit and specific objectives.
   - Discuss information and assignment sheets.
   - Give Test.

2. Unit References:

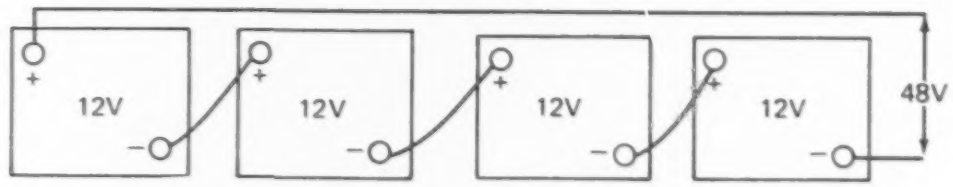
   - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 8th ed. New York: McGraw-Hill Book Co., 1992.
   - *Power Line Technician*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

GENERATORS AND BATTERIES
UNIT 4

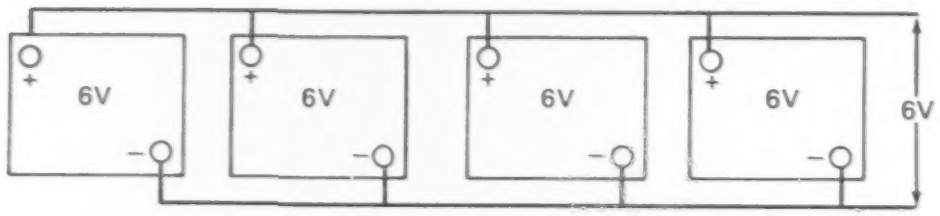
ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet 1

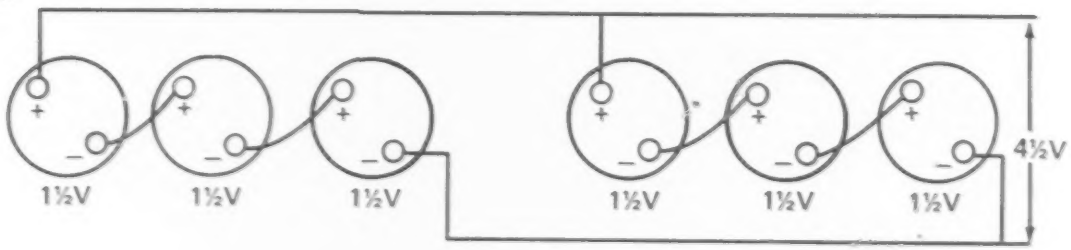
1.



2.



3.



GENERATORS AND BATTERIES
UNIT 4

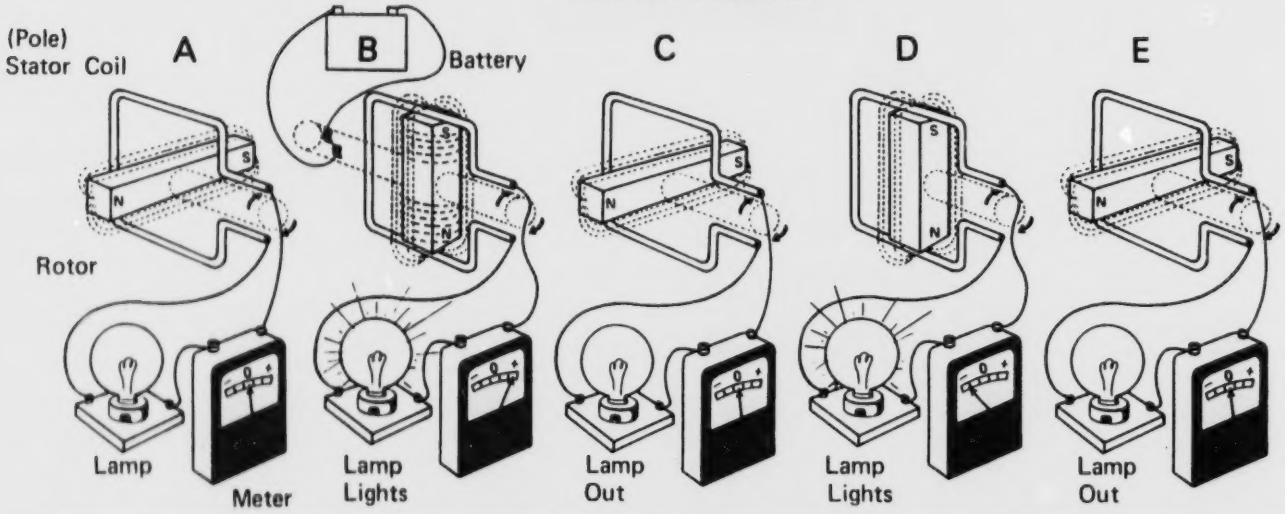
ANSWERS TO TEST

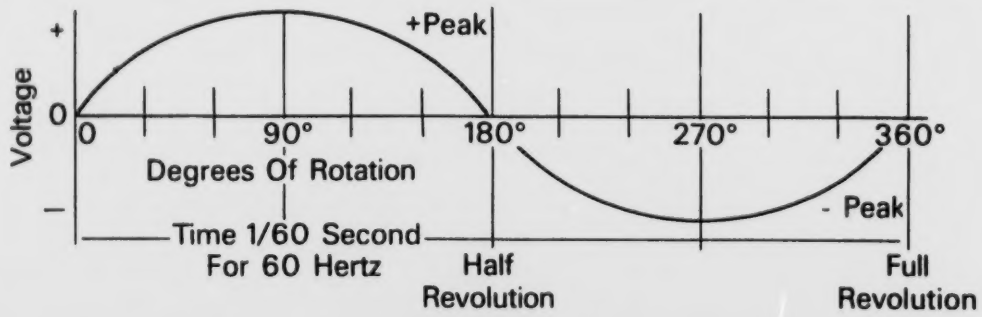
1. a. 4 h. 10
   b. 3 i. 7
   c. 5 j. 8
   d. 1 k. 6
   e. 14 l. 9
   f. 12 m. 11
   g. 2 n. 13
2. a. Hydroelectric
   b. Steam-powered
   c. Diesel-powered
   d. Gasoline-powered
3. a. 3
   b. 2
   c. 1
4. a. 3
   b. 2
   c. 1
   d. 4
5. a. 60
   b. 60
   c. 60

ANSWERS TO TEST

6. a. Ground the generator housing
   b. Use a three-wire power cord with ground wire (120 V supply)
   c. Check all standby generators for live connections
   d. Do not connect a generator to an energized line
7. a. Primary cell
      1) Zinc-carbon
      2) Mercury-zinc
   b. Secondary cell
      1) Lead-acid
      2) Nickel-cadmium
8. a. Series-parallel connected
   b. Series-parallel connected
   c. Parallel connected
   d. Series connected
   e. Parallel connected
9. a, b, d, e
10. a. 2
    b. 1
    c. 3
11. Evaluated on Assignment Sheet 1.

Alternator

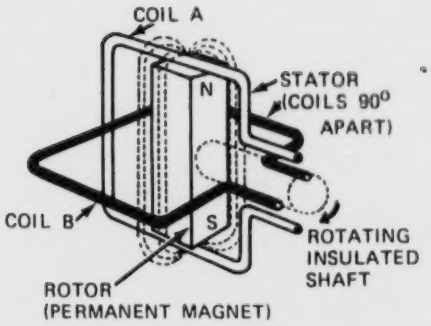




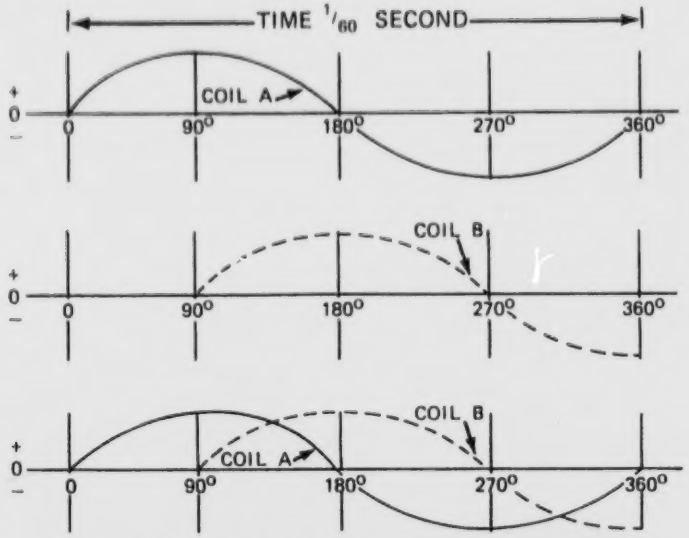
In Figure "B," A Field Coil Has Been Added. The Battery Supplies "Exciting" Current Which Increases The Magnetic Field Around The Rotor. The Stronger Field Around The Rotor Enables The Alternator To Produce A Greater Amount Of Alternating Current.

May be photocopied for student use.

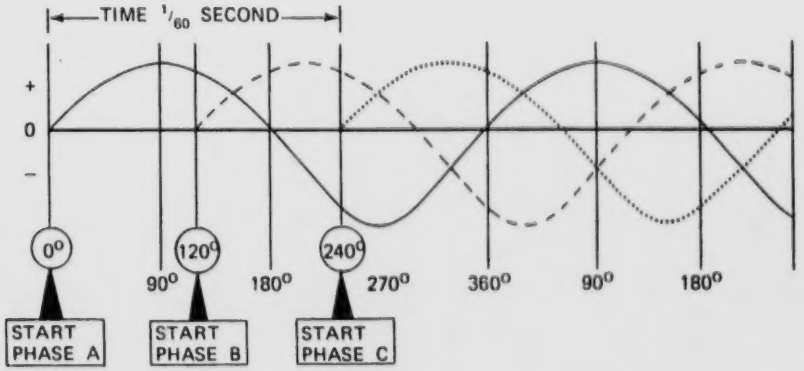
Polyphase Alternator



Polyphase Alternator
(2 Phase)



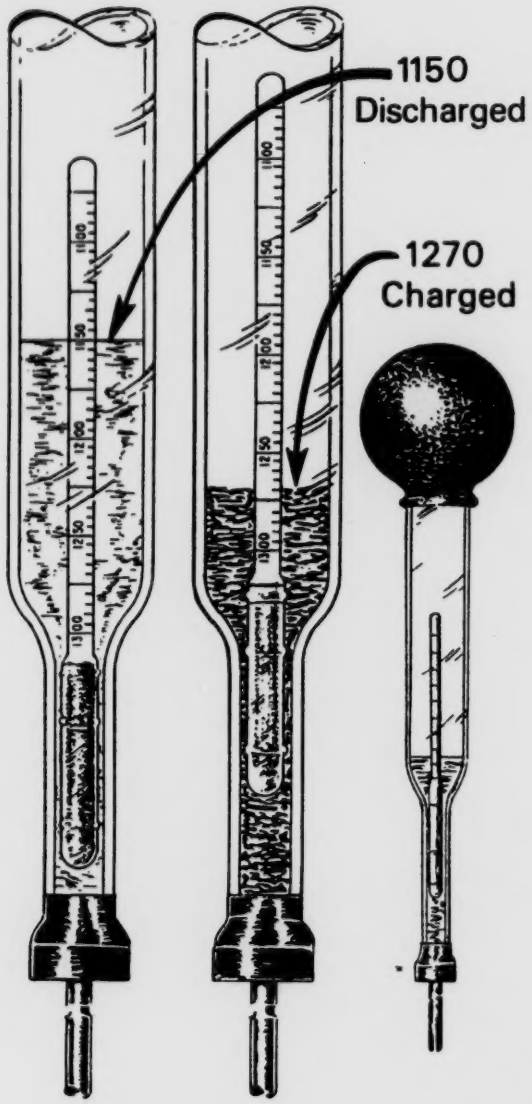
Sine Curves Of A Two-phase Alternator



If A Third Stator Is Added To The Alternator A Three Phase Alternator Would Be Created With The Stators 120 Degrees Apart.

May be photocopied for student use.

Hydrometer

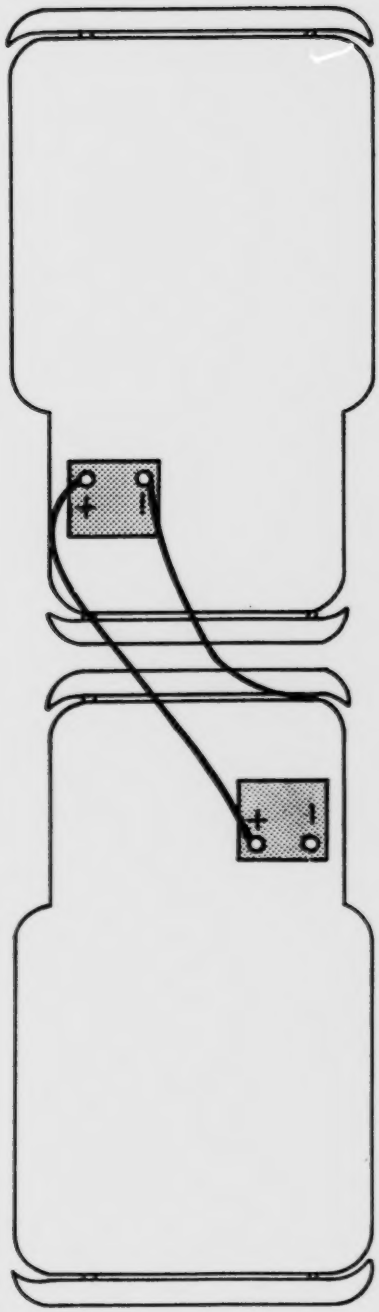


SPECIFIC GRAVITY	STATE OF CHARGE
1.260 to 1.280	Fully charged
1.225 to 1.250	Three-fourths charged
1.195 to 1.220	One-half charged
1.160 to 1.180	One-fourth charged
1.130 to 1.155	Barely usable
1.100 to 1.125	Completely discharged

TM 3

May be photocopied for student use.

Jumping Vehicle Batteries



101

100

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GENERATORS AND BATTERIES
UNIT 4

TEST

NAME _____ SCORE _____

1. Match the terms associated with generators and batteries on the right to the correct definitions. (Definitions are continued on the following page.)

_____a.	Electrical power generated by using flowing water to turn generators	1.	Diesel plant
_____b.	Generation plant powered by steam created by oil, coal, or natural gas heat	2.	Electrolyte
_____c.	Generation plant powered by steam created by atomic energy	3.	Steam plant
_____d.	Generation plant powered by a diesel-fueled engine	4.	Hydroelectric power
_____e.	Alternating current generator which produces current by rotating a magnetic field close to stator coil	5.	Atomic plant
_____f.	Alternator which produces four or more voltage peaks at different intervals in time in one cycle	6.	Secondary cell
_____g.	Sulfuric acid used in lead-acid storage batteries	7.	Hydrometer
_____h.	Weight of electrolyte as compared to water	8.	Primary cell
_____i.	Instrument used to measure the specific gravity of electrolyte in a lead-acid storage battery	9.	Rectifier
_____j.	Electricity-producing cell which is of no value when the electrical activity is exhausted	10.	Specific gravity
_____k.	Electricity-producing cell which can be restored to activity by passing a current through it in a reverse direction	11.	Generator
		12.	Polyphase alternator
		13.	Battery
		14.	Alternator

May be photocopied for student use.

TEST

_____l. Device which converts alternating current to direct current

_____m. Machine that converts mechanical energy to electrical energy

_____n. Two or more primary or secondary cells connected electrically

2. List four kinds of generating plants.

a. _____

b. _____

c. _____

d. _____

3. Match the generators on the right to the voltages produced by each.

_____a. 13,800 to 18,000 volts

_____b. 120 to 480 volts

_____c. 1600 to 2400 volts

1. Diesel-powered plant
2. Gasoline-powered portable generator
3. Steam and hydroelectric plants

4. Match the generators on the right to the specific use.

_____a. Supplies power to large areas

_____b. Supplies power to small towns or supplements larger plants during peak loads

_____c. Supplies emergency or standby power for farms and businesses

_____d. Supplies temporary power for construction sites for power tools and lighting

1. Gasoline-powered mobile or stationary generator
2. Diesel-powered plant
3. Hydroelectric or steam plant
4. Gasoline-powered portable generator

May be photocopied for student use.

TEST

5. Calculate the electrical frequency (Hertz) of the following generators.

   _____a. 2 pole generator turning 3600 rpm

   _____b. 4 pole generator turning 1800 rpm

   _____c. 96 pole generator turning 75 rpm

6. List four precautions to observe with the use of portable generators.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

   d. _____

   _____

7. List two kinds of voltage-producing primary cells and two kinds of secondary cells.

   a. Primary cell

      1) _____

      2) _____

   b. Secondary cell

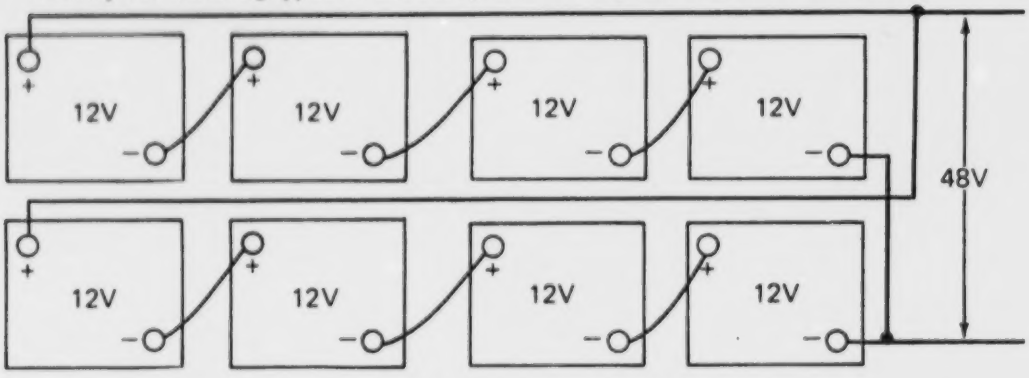
      1) _____

      2) _____

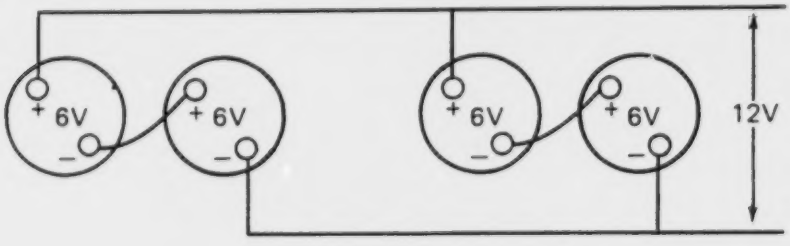
May be photocopied for student use.

TEST

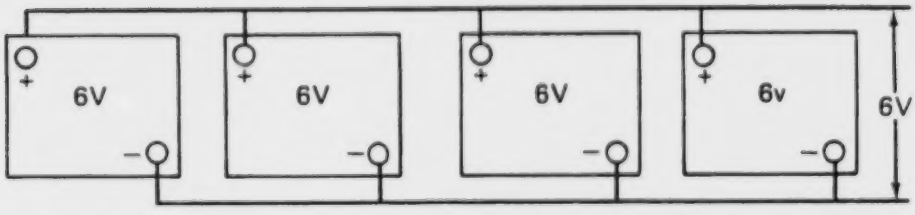
8. Identify the following types of circuits. (Answers may be used more than once.)



a. _____



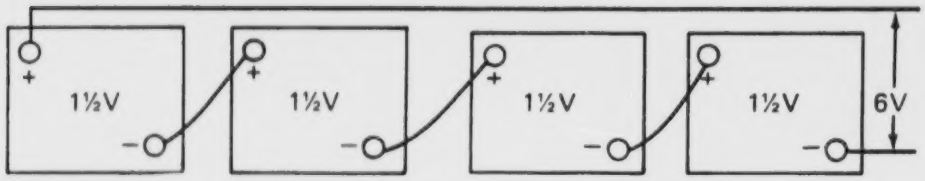
b. _____



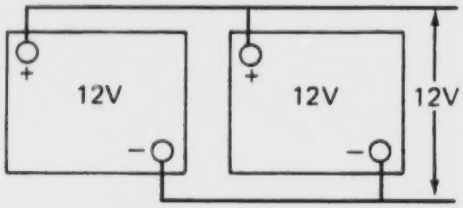
c. _____

May be photocopied for student use.

TEST



d. _____



e. _____

9. Select from the list below the precautions to observe when connecting batteries. Place an "X" in the blanks provided.

_____a. Do not allow sparks or open flame near a lead-acid battery

_____b. Do not series-connect batteries unless the voltage desired is more than the voltage of one battery

_____c. Check battery by placing jumper across terminals

_____d. Wear eye protection

_____e. Do not short-circuit a battery

_____f. Store batteries on concrete floor

10. Arrange in order the following steps to follow to connect lead-acid batteries when starting equipment.

_____a. Connect jumper to negative terminal of charged battery

_____b. Connect jumper to positive terminal of each battery

_____c. Connect other end of jumper to the frame of equipment being started

11. Evaluated on Assignment Sheet 1.

May be photocopied for student use.

WORK PROCEDURES
(NONENERGIZED)
UNIT 5

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information and assignment sheets.
   - Provide student with specifications for 7.2/12.5 kV line construction.
   - Make transparencies.
   - Discuss unit and specific objectives.
   - Discuss information and assignment sheets.
   - Discuss staking sheet used by local organization.
   - Use local area maps for areas not in Oklahoma.
   - Give test.

2. Unit references:

   - Kurtz, Edwin D., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 8th ed. New York: McGraw-Hill Book Co., 1992.
   - *National Electrical Code 1993*. Quincy, MA: National Fire Protection Association, 1992.
   - *Power Line Technician*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

WORK PROCEDURES
(NONENERGIZED)
UNIT 5

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. A1
   a. 2, 5/8" machine bolts
   b. 1 pin insulator
   c. 1 spool insulator
   d. 3, 2 1/4" square washers
   e. 3 locknuts
   f. 1 single upset bolt
   g. 1, 20" pole top pin
2. A1-1
   a. 2, 5/8" machine bolts
   b. 2 pin insulators
   c. 1 spool insulator
   d. 3, 2 1/4" square washers
   e. 3 locknuts
   f. 1 single upset bolt
   g. 2, 20" pole top pins
   h. 2, 3/4" pipe spacers
3. A3
   a. 2, 5/8" eye bolts
   b. 2 suspension insulators
   c. 1 spool insulator

ANSWERS TO ASSIGNMENT SHEETS

d. 2, 2 1/4" square washers

e. 2 locknuts

f. 1 anchor shackle

g. 1 primary angle assembly

h. 1 neutral angle assembly

4. A5

a. 2, 5/8" eye bolts

b. 2 suspension insulators

c. 1 spool insulator

d. 2, 2 1/4" square washers

e. 2 locknuts

f. 1 primary dead-end assembly

g. 1 neutral dead-end assembly

Assignment Sheet 2

1. Poles

Number	Size (length) and Class
2	35-5
5	35-6
1	30-6

2. Primary assemblies

Number	Unit
4	A-1
1	A1-1
1	A-3
1	A-5
1	A5-2

ANSWERS TO ASSIGNMENT SHEETS

3. Pole grounds — Approximate total feet ground wire — 280

Number	Unit	Number of ground rods and clamps — 3
3	M2-1	
5	M2-2	

4. Primary conductor

Type	Feet
#4ACSR	4,420

5. Service conductor

Type	Feet
#2TPX	60

6. Service assemblies

Number	Unit
2	K-14

7. Guys

Number	Unit
3	E1-2

8. Anchors

Number	Unit
3	F1-2

9. Armor rods

Number
14

10. Connectors

Number
24

ANSWERS TO ASSIGNMENT SHEETS

11. Miscellaneous assemblies

Number	Unit
1	M8-9

Assignment Sheet 3

1.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

2. a. 22 c. 4 e. 10 g. 21 i. 2
   b. 9 d. 26 f. 18 h. 9 j. 35

Assignment Sheet 4

1. a. Hohmann Airport
   b. Oklahoma State Reformatory
   c. Lone Wolf
2. a. SEC. 22 T7N R19W
   b. SEC. 23 T5N R19W
   C. SEC. 25 & Sec. 26 T6N R21W
3. 114 miles
4. 31 miles

WORK PROCEDURES (NONENERGIZED) UNIT 5

ANSWERS TO TEST

1.

a.	6	g.	3.	m.	17		
b.	7	h.	4	n.	18		
c.	1	i.	8	o.	16		
d.	5	j.	10	p.	14		
e.	9	k.	12	q.	15		
f.	2	l.	11	r.	13		

2. a, b, d, e, f, g, h, i, j, k, l, m, n, o, p, q

3.

a.	8	g.	7	m.	14	s.	1
b.	10	h.	12	n.	17		
c.	3	[illegible]	5	o.	16		
d.	6	j.	4	p.	19		
e.	11	k.	9	q.	15		
f.	13	l.	18	r.	2		

4. a. Attach service to house or building and connect service to consumer's meter loop
   b. Pull service wire from transformer pole
   c. Place neutral wire in dead-end clamp and adjust service wire to proper sag
   d. Connect service neutral to line neutral
   e. Connect insulated service conductors to transformer lugs

5. a. Use connector suitable for type of conductors being connected
   b. Connect grounding conductors before connecting current-carrying conductors
   c. Remove enough insulation to prevent connector from overlapping insulation
   d. Use inhibitor on all aluminum or aluminum to copper connections

ANSWERS TO TEST

6. a. 3 e. 7
   b. 8 f. 6
   c. 4 g. 5
   d. 1 h. 2

7. a. VM2-12
      1) No. 6 or equivalent soft-drawn copper
      2) Connectors
      3) Staples
      4) Butt plate or butt wrap
      5) Galvanized nails for butt plate
   b. M2-1
      1) No. 6 or equivalent soft-drawn copper
      2) Connectors
      3) Steeples
      4) Ground rod
      5) Ground rod clamp

8. Evaluated on Assignment Sheet 1.

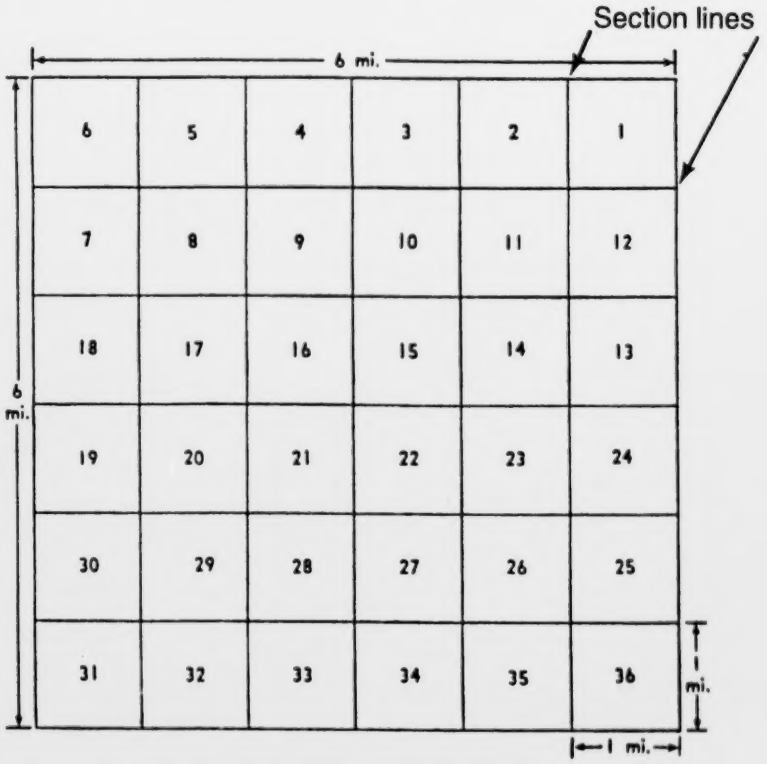
9. Evaluated on Assignment Sheet 2.

10. Evaluated on Assignment Sheet 3.

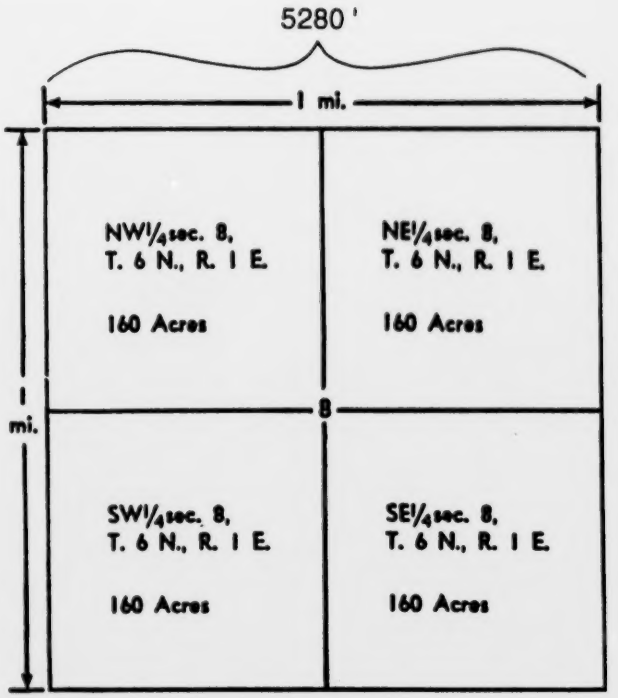
11. Evaluated on Assignment Sheet 4.

Township and Sections

DIVISION OF TOWNSHIP INTO SECTIONS



THE SECTIONS IN EACH TOWNSHIP ARE NUMBERED IN THE SAME MANNER



A SECTION DIVIDED INTO FOUR QUARTERS

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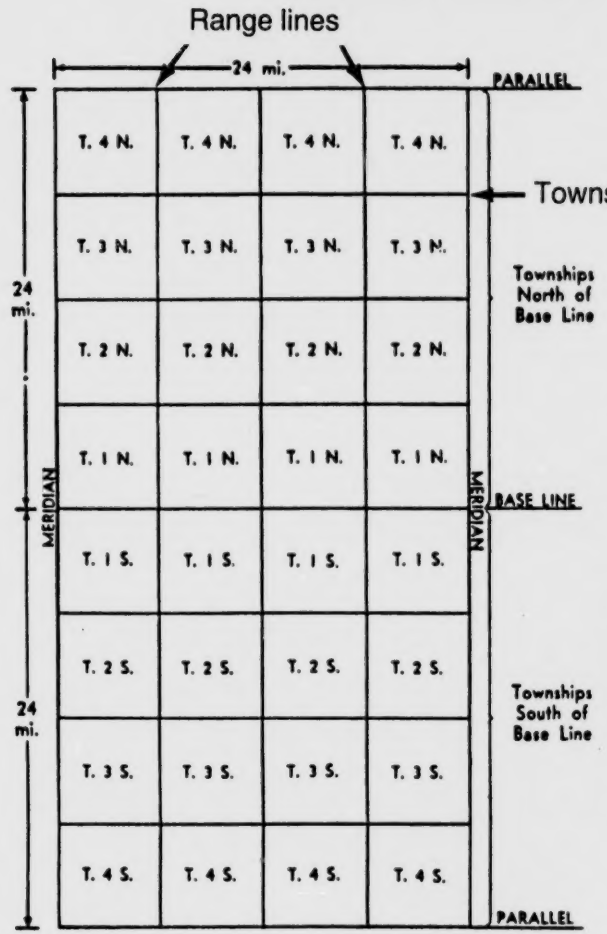
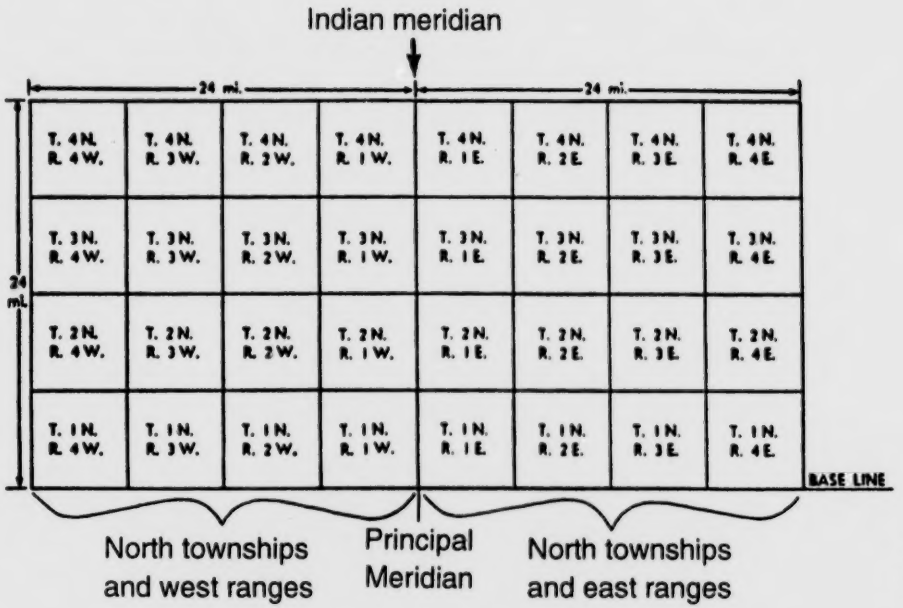
TM 1

PLT C - 5 - 9

Parallels, Meridians, and Ranges





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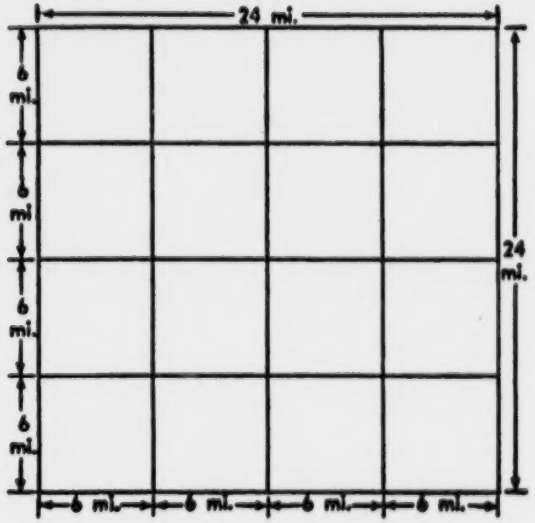
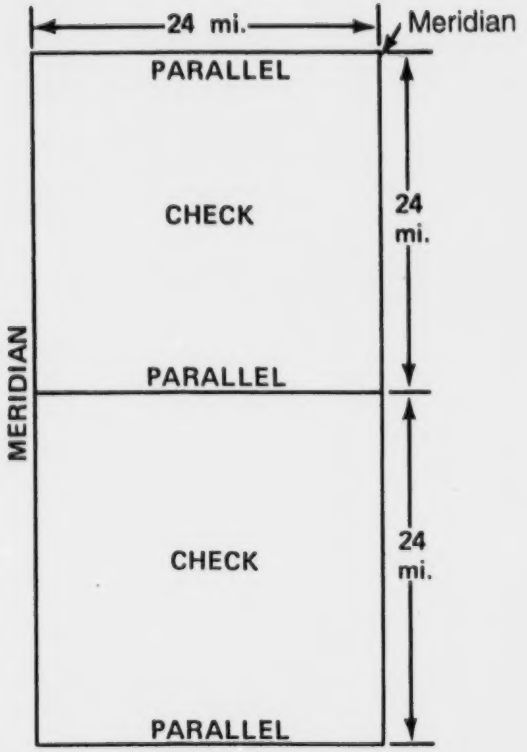
TM 2

PLT C - 5 - 11

Checks



DIVISION OF A CHECK INTO SIXTEEN TOWNSHIPS



CHECKS, PARALLELS, AND MERIDIANS

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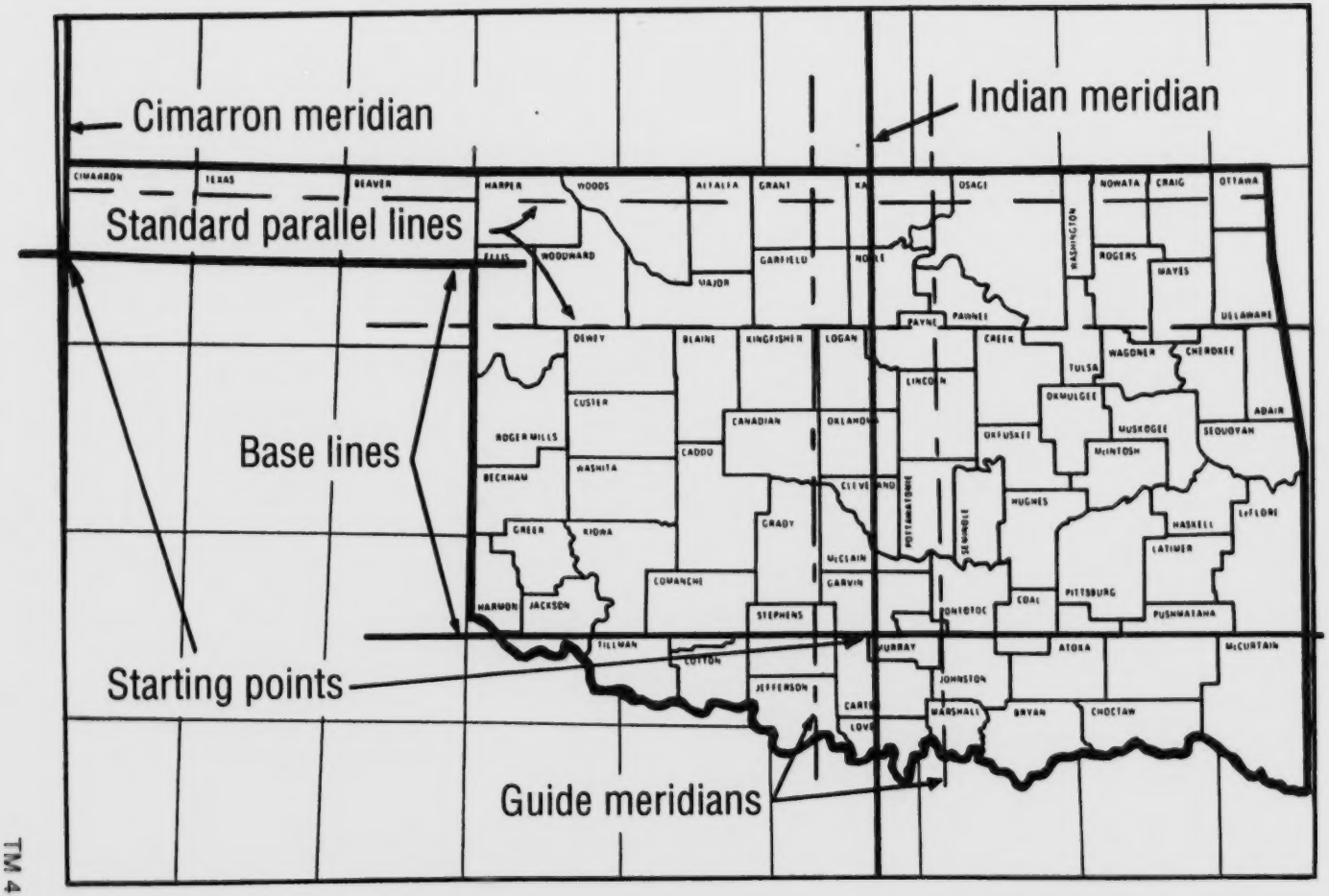
Principal Meridians and Base Lines in Oklahoma



TM 4

PLT C - 5 - 15

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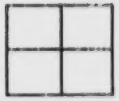
Staking Sheet



N

COUNTY _____ CAMP _____ WORK ORDER NO. _____

TWP. _____ R _____ SEC. _____ MAP REFERENCE _____ PAGE ____ OF ____

BOLIVAR ____ PRESTON ____ J-7 ____ PRI. ____ WIRE ____ SIZE _____ STAKED BY _____

KIND _____ RULING SPAN _____ EXISTING WIRE _____ CODE _____ REVISED BY _____

POLE NO.	PRI. BACK SPAN	POLES H & C MISC.	PRI. UNIT MISC.	R-W CLEAR	LINE ANG	TRAN G	GR M2	GUY			ANC. F	SECONDARY				MOH			SEC OR SER WIRE SIZE	METER		YARD LIGHT
								NO.	UNIT E	LEAD		SPAN		UNIT								
												UNDR	SEC	NO.	J/K	SPAN	NO.	K		LOOP	SIZE	

LEGEND: * RETIRED □ RESET OR DELETE METERS OR TRANSFORMERS

MEMBER INFORMATION

YARD LIGHT # ___ CHARGE $ _____

WORKED BY _____

DATE COMPLETED _____

_____

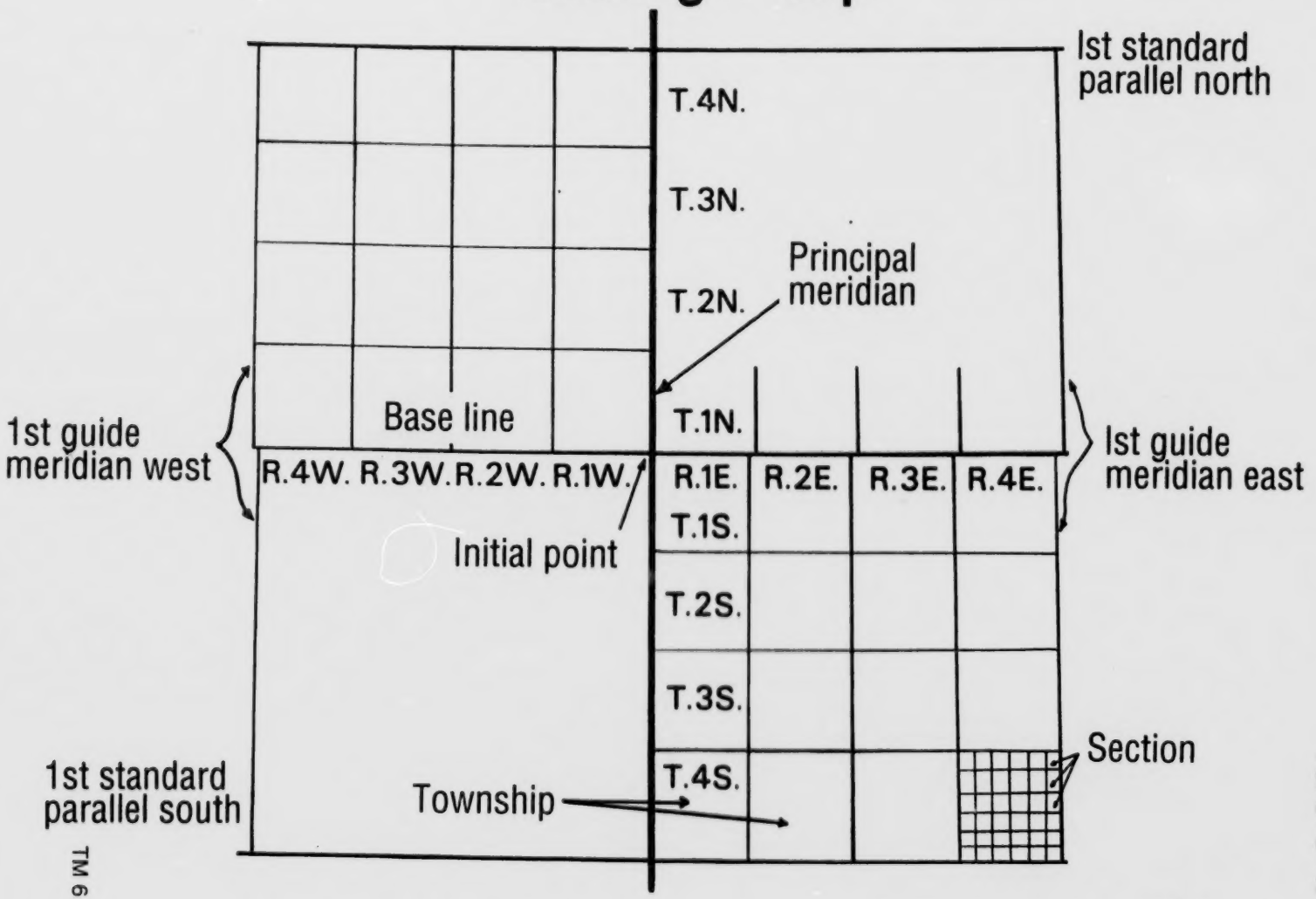
_____

_____

_____

May be photocopied for student use.

Reading a Map



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WORK PROCEDURES
(NONENERGIZED)
UNIT 5

TEST

NAME _____ SCORE _____

1. Match the terms associated with work procedures on the right to the correct definitions. (Answers to "a" through "l" are on this page.)

_____a.	Shows materials needed, location, and sketch of work to be done	1.	Guy lead
_____b.	Average span plus two-thirds of the difference between the longest span and the average span	2.	Quarter section
_____c.	Distance between the pole to be guyed and the anchor	3.	Range
_____d.	Area six miles square which is divided into thirty-six sections	4.	Meridian
_____e.	Area one mile square	5.	Township
_____f.	Area of a section one-half mile square	6.	Staking sheet
_____g.	Location of a township either east or west of a principal meridian	7.	Ruling span
_____h.	Line running north and south through the state every twenty-four miles	8.	Principal meridian
_____i.	Meridian which divides the east and west halves of the state	9.	Section
_____j.	Principal meridian in Oklahoma	10.	Indian Meridian
_____k.	Location of property according to township, range, section, and quarter section	11.	Section line
_____l.	Line set at one mile intervals which runs both east and west and north and south through the state	12.	Legal description

May be photocopied for student use.

TEST

_____m. Line which runs east and west through the state every six miles

_____n. Materials and methods of line construction recommended by REA

_____o. Area twenty-four miles square which contains sixteen townships

_____p. Line which runs east and west through the state every twenty-four miles

_____q. Parallel in the southern part of the state; the south boundary of the Oklahoma panhandle counties from which ranges are measured

_____r. Designation given a meter location which indicates the location according to a legal description

13. Account number
14. Parallel
15. Base line
16. Check
17. Range line
18. Specification book

2. Select from the following list the items of information found on a staking sheet by placing an "X" in the blanks. (Items are continued on the following page.)

_____a. Size and type of primary conductor

_____b. Span lengths

_____c. Electricity rate schedule

_____d. Primary assemblies

_____e. Miscellaneous assemblies

_____f. Pole numbers

_____g. Heights and classes of poles

_____h. Types and sizes of guys and anchors

_____i. Secondary assemblies

_____j. Recap of all materials needed

_____k. Service size and length

_____l. Sketch of line

_____m. Location

May be photocopied for student use.

TEST

_____n. Grounding assemblies

_____o. Transformer type and size

_____p. Right-of-way to be cleared

_____q. Size and type of meter

3. Arrange in proper order the procedure for line construction.

_____a. Frame poles

_____b. Set and tamp poles and anchors

_____c. Get job assignment

_____d. Load poles and conductor

_____e. Pull and make up guys

_____f. Lay up conductor, sag, and tie in

_____g. Haul and place poles near line stakes

_____h. String conductor along pole line

_____i. Gather materials

_____j. Read staking sheets

_____k. Dig holes for poles and anchors

_____l. Set meter and record information

_____m. Hang transformers

_____n. Check voltage at meter base

_____o. Remove ground cables and energize line

_____p. Sign or initial staking sheet

_____q. Connect grounds and service wire

_____r. Inspect vehicle

_____s. Document tailgate discussion

May be photocopied for student use.

TEST

4. List steps to follow when installing service wire. Write the step relating to the key words provided.

   a. Attach and connect — _____

   _____

   b. Transformer pole — _____

   _____

   c. Dead-end clamp — _____

   _____

   d. Service neutral — _____

   _____

   e. Transformer lugs — _____

   _____

5. State the procedure for connecting service wire. Write the step relating to the key words provided.

   a. Connector suitability — _____

   _____

   _____

   _____

   b. Connect — _____

   _____

   _____

   _____

   c. Remove insulation — _____

   _____

   _____

   _____

May be photocopied for student use.

TEST

d. Inhibitor — _____

_____

_____

_____

6. Match the assemblies on the right to the materials needed.

_____a. Pin type insulators; spool insulator; 20" pole top pins; single upset bolt; 5/8" machine bolts; 3/4" x 1 1/2" pipe spacers; 2 1/4" square washers; locknuts

_____b. Swinging secondary clevis; spool insulator

_____c. 2 1/4" square washers; suspension insulator; 5/8" eye bolt; connectors; 5/8" eye nut; jumper; primary dead-end assembly; neutral dead-end assembly; anchor shackle; locknuts

_____d. Swinging secondary clevis; spool insulator; loop dead-end clamp; armor tape

_____e. Pin type insulator; spool insulator; 20" pole top pin; single upset bolt; 5/8" machine bolts; 2 1/4" square washers; locknuts

_____f. 2 1/4" square washers; suspension insulators; 5/8" eye bolts; anchor shackle; primary angle assembly; neutral angle assembly

_____g. Dead-end clamp; armor tape

_____h. 2 1/4" square washers; suspension insulators; 5/8" eye bolt; primary dead-end assembly; neutral dead-end assembly; locknuts

1. Neutral dead-end assembly
2. A5
3. A1-1
4. A5-2
5. Primary dead-end assembly
6. A3
7. A1
8. Neutral angle assembly

7. List the materials needed to install the pole ground assemblies listed.

a. VM2-12

1) _____

2) _____

May be photocopied for student use.

TEST

3) _____

4) _____

5) _____

b. M2-1

1) _____

2) _____

3) _____

4) _____

5) _____

8. Evaluated on Assignment Sheet 1.

9. Evaluated on Assignment Sheet 2.

10. Evaluated on Assignment Sheet 3.

11. Evaluated on Assignment Sheet 4.

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A CIMC "RAINBOW PROGRAM"

FOR STANDARDS OF TEACHING EXCELLENCE

One very important factor contributing to higher student performance is the expectation of parents and teachers. Experience suggests that teachers and parents who expect student success find that students perform better, attend class more regularly, have positive attitudes, and stay in school longer. The students' success and confidence in their ability to learn may cause additional growth and behaviors that exert a positive influence throughout life.

STUDENT'S PROMISE

Let it be publicly known that students in this program have high expectations of [illegible]

I recognize that America's future is dependent on my success in school.
I will attend school regularly.
I will keep regular study hours at home.
I will read each day at home.
I will never accept failure.
I will accept responsibility for my school challenges.
I will respect the rights and feelings of others at home, school, and work.
I will develop positive qualities in myself that my friends will admire.
If I have difficulty, I will insist on help with my school work.
If I have difficulty, I will always try harder.
I will ask my teacher for clear learning objectives.
I will practice good citizenship skills at home, school, and work.
I will keep my parents/guardians informed daily about my school activities.
I will develop goals for school, home, and work.
I will seek advice from my teachers, parents/guardians, and counselors on career guidance.
I will constantly practice the skills of a good student.

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Power Line Technician

Second Edition

Module C

- Poles
- Conductors
- Grounding and Connecting
- Generators and Batteries
- Work Procedures (Nonenergized)

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Student Workbook

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Power Line Technician: Module C

Student Workbook

Developed by the
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4. Rope and Rigging
5. Overhead Construction
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7. Personal Climbing Tools and Equipment
8. Right-of-Way
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POLES
UNIT 1

UNIT OBJECTIVE

After completion of this unit, the student should be able to list methods used to set poles and to support unsafe poles for climbing. The student should be able to select from a list precautions to observe when handling poles and arrange in order the steps for pole inspection. The student should be able to read tables to determine classes and weights of poles. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with poles to the correct definitions.
2. List five types of preservatives used on poles.
3. Match the type of preservatives used on poles with their code letters.
4. Select from a table the classes of poles of varying lengths and circumferences.
5. Select from a list precautions to observe when handling poles.
6. Calculate the weights of various classes and lengths of commonly used poles using a table.
7. List methods used to set poles.
8. State the correct procedure for checking a pole before climbing.
9. Arrange in proper order the steps for pole inspection.
10. List methods used to support unsafe poles for climbing.
11. State the correct method for storing poles.
12. Select from a table the classes of poles of varying lengths and circumferences. (Assignment Sheet 1)
13. Calculate the weights of various classes and lengths of commonly used poles using a table. (Assignment Sheet 2)

POLES
UNIT 1

INFORMATION SHEET

1. Match the terms associated with poles to the correct definitions.

   - Preservative — Solution forced into pole to increase its life expectancy
   - Face — Concave side; side of greatest curvature between groundline and top of pole
   - Groundline section — Portion of pole one foot above and two feet below groundline
   - Short crook — Deviation from straightness in any five foot or shorter section which deviates more than one-half the diameter of the crooked section
   - Sweep — Deviation of a pole from straightness
   - Check — Separation of the wood along the grain
   - Cross break — Separation of the wood across the grain
   - Split — Lengthwise separation of the wood cells through the full diameter of the pole
   - Shake — Separation along the grain between the rings of annual growth

2. List five types of preservatives used on poles.

   - Creosote oil
   - Pentachlorophenol
   - Chromated copper arsenates (CCA)
   - Ammoniacal copper fatty acid
   - Copper naphthenate

INFORMATION SHEET

3. Match the type of preservatives used on poles with their code letters.

Preservative Solution	Code
Creosote	C
Creosote/coal tar solution	T
Creosote/petroleum solution	X
Copper naphthenate solution	N
Penta (pentachlorophenol) solution	P
Salt solution	S

(NOTE: Gloves and protective clothing should always be worn when working with chemically treated poles and crossarms.)

4. Select from a table the classes of poles of varying lengths and circumferences.

Class	1	2	3	4	5	6	7	9	10
Minimum Circumference at Top (Inches)	27	25	23	21	19	17	15	15	12

Length of Pole (Feet)	Groundline Distance from Butt (Feet)	Minimum Circumference at 6 Feet from Butt (Inches)								
20	4	31.0	29.0	27.0	25.0	23.0	21.0	19.5	17.5	14.0
25	5	33.5	31.5	29.5	27.5	25.5	23.0	21.5	19.5	15.0
30	5.5	36.5	34.0	32.0	29.5	27.5	25.0	23.5	20.5	
35	6	39.0	36.5	34.0	31.5	29.0	27.0	25.0		
40	6	41.0	38.5	36.0	33.5	31.0	28.5	26.5		
45	6.5	43.0	40.5	37.5	35.0	32.5	30.0	28.0		
50	7	45.0	42.0	39.0	36.5	34.0	31.5	29.0		
55	7.5	46.5	43.5	40.5	38.0	35.0	32.5			
60	8	48.0	45.0	42.0	39.0	36.0	33.5			
65	8.5	49.5	46.5	43.5	40.5	37.5				
70	9	51.0	48.0	45.0	41.5	38.5				
75	9.5	52.5	49.0	46.0	43.0					
80	10	54.0	50.5	47.0	44.0					
85	10.5	55.0	51.5	48.0						
90	11	56.0	53.0	49.0						
95	11	57.0	54.0	50.0						
100	11	58.5	55.0	51.0						
105	12	59.5	56.0	52.0						
110	12	60.5	57.0	53.0						
115	12	61.5	58.0							
120	12	62.5	59.0							
125	12	63.5	59.5							

Example: A 35-foot class 5 pole would measure 19" circumference at the top and at least 29" circumference 6' from the butt

INFORMATION SHEET

5. Select from a list precautions to observe when handling poles.

- Use suitable equipment to lift pole
- Attach sling or cable to pole by laying sling on ground and rolling pole onto sling
- Move pole with cant hook or bar by working from the ends of pole
- Roll pole away from yourself when moving it
- Do not stand or walk on stacked poles
- Do not use cant hook or pole carrying hook in groundline section of pole
- Do not drop pole from vehicle or pole rack
- Do not drag pole

6. Calculate the weights of various classes and lengths of commonly used poles using a table. (Assignment Sheet 2)

Length of Pole in Feet	Class						
	1	2	3	4	5	6	7
	Pounds						
25	990	811	674	573	491	422	344
30	1279	1082	921	784	660	550	454
35	1568	1343	1155	1004	862	743	646
40	1884	1623	1403	1219	1059	921	807
45	2223	1911	1664	1444	1274	1114	976
50	2585	2214	1925	1687	1494	1329	1169
55	2993	2567	2200	1934	1719	1563	
60	3451	2943	2512	2186	1953	1801	
65	4015	3341	2814	2457	2237		
70	4620	3781	3144	2732	2488		
75	5198	4235	3506	3021			
80	6400	5170	4240	3615			
85	7200	5745	4690				
90	8140	6405	5160				

Example: A 30-foot class 3 pole would weigh 921 pounds

(NOTE: Pole weight is an important factor when loading poles on mobile equipment to prevent overloading equipment.)

INFORMATION SHEET

7. List methods used to set poles.

   - Pike (Transparency 1)
   - Gin pole (Transparency 2)
   - A-frame (Transparency 3)
   - Boom or digger derrick (Transparency 4)

8. State the correct procedure for checking a pole before climbing.

   - Check pole brand for proper depth
   - Inspect pole visually for unauthorized attachments and cracked or broken insulators

     (NOTE: A cracked or broken insulator may shatter when sounding or climbing a pole. Severe injury can result from falling porcelain.)

   - Sound pole with hammer

     (NOTE: A crisp, solid sound indicates that the wood is good. A dull sound indicates decay and a hollow sound indicates a hollow heart.)

   - Check for woodpecker holes and loose hardware

9. Arrange in proper order the steps for pole inspection.

   - Read and record brand information
   - Check for broken insulators
   - Sound the pole above ground
   - Excavate the pole to a depth of 18"
   - Sound the pole below ground

     (NOTE: If there is an indication of unsound wood, the next step should be included in inspection.)

   - Bore the pole with a 3/8" bit

     (NOTE: All bored holes should be filled with tight-fitting, treated plugs.)

INFORMATION SHEET

10. List methods used to support unsafe poles for climbing.

- A-Frame and metal stub (Transparency 5)
- Temporary guy (Transparency 6)
- Digger derrick (Transparency 7)
- Pole pike
- Pole stub

11. State the correct method for storing poles.

Poles should be stored on racks with each layer separated or laid at a right angle to the layer below to allow for circulation of air.

POLES
UNIT 1

ASSIGNMENT SHEET 1

OBJECTIVE 12 — SELECT FROM A TABLE THE CLASSES OF POLES OF VARYING LENGTHS AND CIRCUMFERENCES.

Select the correct class of each of the following sizes and lengths of poles.

	Length of Pole	Circumference at Top	Circumference 6' from Butt	Class
1.	55'	22"	38"	_____
2.	40'	18"	29"	_____
3.	30'	26"	35"	_____
4.	35'	22"	32"	_____

Class	1	2	3	4	5	6	7	9	10
Minimum Circumference at Top (Inches)	27	25	23	21	19	17	15	15	12

Length of Pole (Feet)	Groundline Distance from Butt (Feet)	Minimum Circumference at 6 Feet from Butt (Inches)								
20	4	31.0	29.0	27.0	25.0	23.0	21.0	19.5	17.5	14.0
25	5	33.5	31.5	29.5	27.5	25.5	23.0	21.5	19.5	15.0
30	5.5	36.5	34.0	32.0	29.5	27.5	25.0	23.5	20.5	
35	6	39.0	36.5	34.0	31.5	29.0	27.0	25.0		
40	6	41.0	38.5	36.0	33.5	31.0	28.5	26.5		
45	6.5	43.0	40.5	37.5	35.0	32.5	30.0	28.0		
50	7	45.0	42.0	39.0	36.5	34.0	31.5	29.0		
55	7.5	46.5	43.5	40.5	38.0	35.0	32.5			
60	8	48.0	45.0	42.0	39.0	36.0	33.5			
65	8.5	49.5	46.5	43.5	40.5	37.5				
70	9	51.0	48.0	45.0	41.5	38.5				
75	9.5	52.5	49.0	46.0	43.0					
80	10	54.0	50.5	47.0	44.0					
85	10.5	55.0	51.5	48.0						
90	11	56.0	53.0	49.0						
95	11	57.0	54.0	50.0						
100	11	58.5	55.0	51.0						
105	12	59.5	56.0	52.0						
110	12	60.5	57.0	53.0						
115	12	61.5	28.0							
120	12	62.5	59.0							
125	12	63.5	59.5							

POLES
UNIT 1

ASSIGNMENT SHEET 2

OBJECTIVE 13 — CALCULATE THE WEIGHTS OF VARIOUS CLASSES AND LENGTHS OF COMMONLY USED POLES USING A TABLE.

Use the table below to calculate the total weight of the following classes and lengths of poles.

1. Two 25' class 6 poles = _____
2. Seven 35' class 5 poles = _____
3. One 30' class 7 poles = _____
4. Two 40' class 4 poles = _____
5. Total weight of all poles = _____

Estimated Weights for Southern Yellow Pine Poles

Length of Pole in Feet	Class						
	1	2	3	4	5	6	7
	Pounds						
25	990	811	674	573	491	422	344
30	1279	1082	921	784	660	550	454
35	1568	1343	1155	1004	862	743	646
40	1884	1623	1403	1219	1059	921	807
45	2223	1911	1664	1444	1274	1114	976
50	2585	2214	1925	1687	1494	1329	1169
55	2993	2567	2200	1934	1719	1563	
60	3451	2943	2512	2186	1953	1801	
65	4015	3341	2814	2457	2237		
70	4620	3781	3144	2732	2488		
75	5198	4235	3506	3021			
80	6400	5170	4240	3615			
85	7200	5745	4690				
90	8140	6405	5160				

CONDUCTORS
UNIT 2

UNIT OBJECTIVE

After completion of this unit, the student should be able to reel out conductor by various methods, join conductor, and determine conductor clearances. The student should be able to install an armor rod and various conductor ties. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with line conductors to the correct definitions.
2. List methods used to protect line conductor at supports.
3. Arrange in order the steps to follow when joining ACSR conductors.
4. Arrange in order the steps to follow when joining CWC conductors.
5. List classes of conductors.
6. List methods of reeling out conductor.
7. Identify various types of conductor ties.
8. Match types of conductors to their specific use.
9. State conductor clearance from ground, roofs and building walls for conductors carrying 750 volts or less.
10. State conductor clearance from ground for conductors carrying over 750 volts to 22,000 volts.
11. Match current-carrying capacities of various ACSR conductors to the correct conductor size.
12. Match current-carrying capacities of various copperweld copper conductors to the correct conductor size.
13. Install a preformed line tie on ACSR conductor on a de-energized circuit. (Job Sheet 1)
14. Install a top groove conductor tie on a de-energized copper conductor. (Job Sheet 2)
15. Install a preformed armor rod on ACSR conductor. (Job Sheet 3)
16. Join ACSR conductor. (Job Sheet 4)

CONDUCTORS
UNIT 2

INFORMATION SHEET

1. Match terms associated with line conductors to the correct definitions.

   - Copperweld — Steel core conductor with a welded coating of copper
   - ACSR — Aluminum conductor steel reinforced
   - CWC — Copperweld copper conductor
   - AWG — American Wire Gauge, the standard gauge for copper, aluminum, and other conductors
   - Brown and Sharpe — The previous standard, now known as American Wire Gauge (AWG)
   - Anneal — To heat and let cool slowly to soften
   - Hard-drawn wire — Wire which has been tempered for strength
   - Soft-drawn wire — Annealed wire
   - Alumoweld wire — Steel wire with a welded coating of aluminum
   - Circular mil — Area of a circle which is one-thousandth of an inch in diameter
   - Kcmil — One thousand circular mils
   - Static wire — Steel conductor strung above transmission lines for a ground wire
   - Weatherproofing — Coating of neoprene or of braided cotton saturated with an asphalt compound
   - Armor tape — Flat aluminum ribbon one-fourth inch wide
   - Kilovolt (kV) — Unit of measure of electromotive force equal to one thousand volts
   - Crimping tool — Tool used to join conductor with a sleeve

2. List methods used to protect line conductor at supports. (Transparency 1)

   - Preformed armor rod
   - Clip type armor rod
   - Preformed conductor tie
   - Armor tape

INFORMATION SHEET

3. Arrange in order the steps to follow when joining ACSR conductors.

   - Select proper sleeve for wire size
   - Select proper crimping tool
   - Remove aluminum strands from steel core the distance recommended by splice manufacturer
   - Clean conductor with conductor brush
   - Slide conductor sleeve onto conductor
   - Install and crimp core sleeve

     (NOTE: Some ACSR sleeves may not require a core sleeve.)
   - Slide center of conductor sleeve to center of core sleeve
   - Crimp conductor sleeve from center of sleeve outward

4. Arrange in order the steps to follow when joining CWC conductors.

   - Select proper sleeve for wire size
   - Select proper crimping tool
   - Clean conductor with conductor brush
   - Install sleeve and crimp from center of sleeve outward

5. List classes of conductors.

   - Solid
   - Stranded

6. List methods of reeling out conductor.

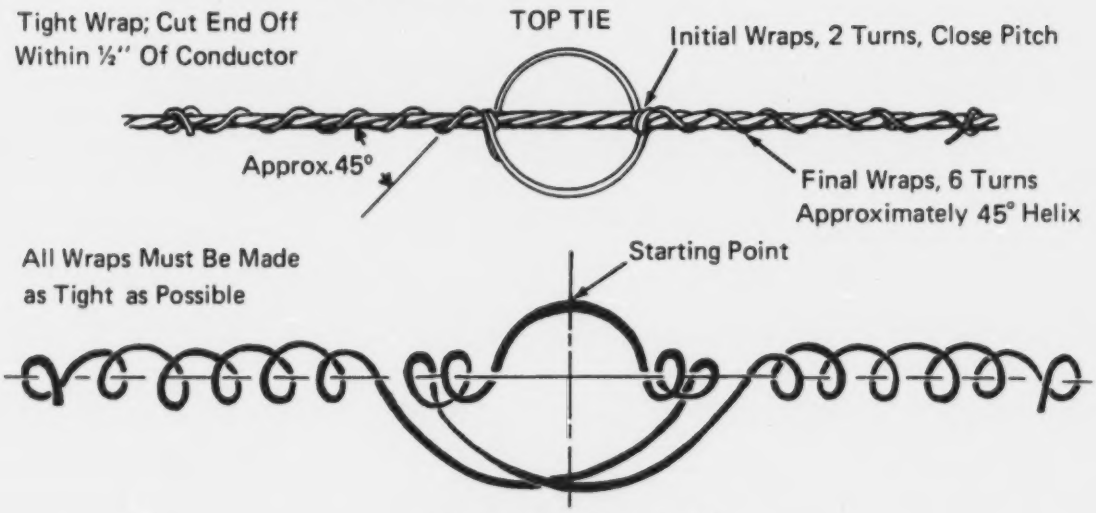
   - Tie off end of conductor and move reel along line route
   - Set up reel and pull conductor through structures or along the ground
   - Set up anchored reel with braking system and pull conductor under controlled tension through structures

     (NOTE: When pulling conductor from stationary reel, do not drag conductor over sharp objects or allow damage to insulated conductor.)

INFORMATION SHEET

7. Identify various types of conductor ties.

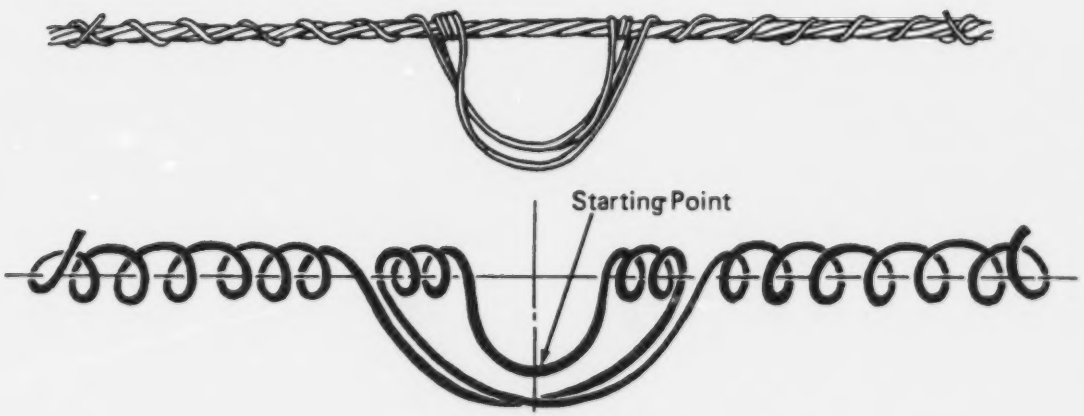
- Copper conductor top groove



TOP TIE DETAIL VIEW

- Copper conductor side groove

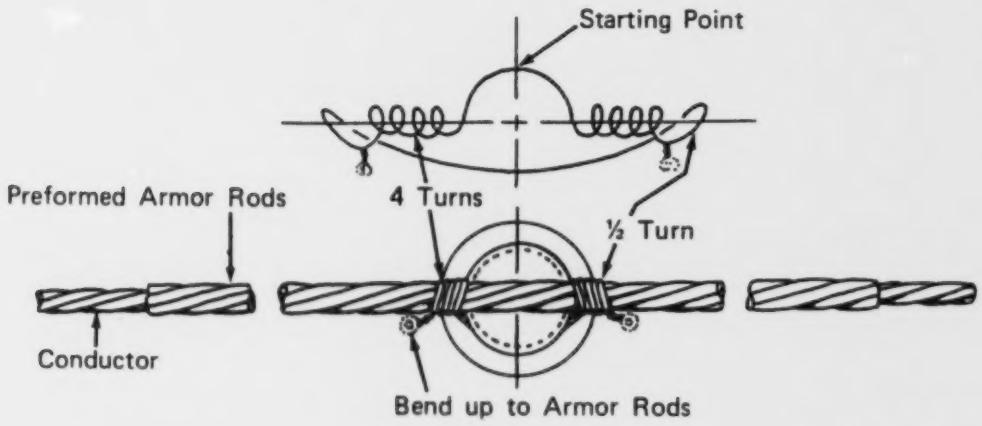
(NOTE: Tie wire must be annealed copper.)



SIDE TIE DETAIL VIEW

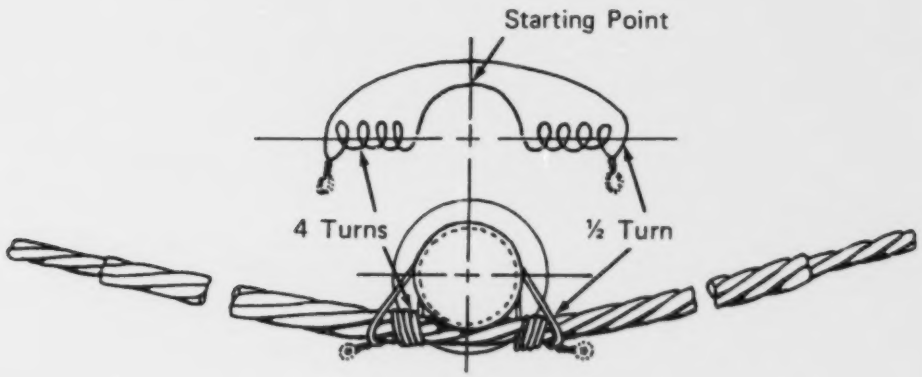
INFORMATION SHEET

- Copper conductor top groove hot line tie



- Copper conductor side groove hot line tie

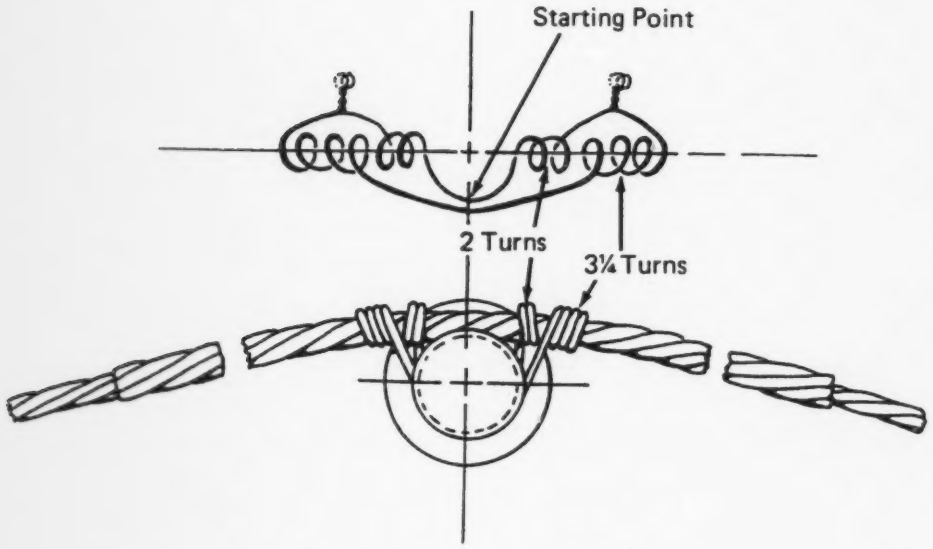
1.



(NOTE: Tie wire assembly should be as tight as can be wrapped by hand. The ends should be twisted with hot line tools. Twist left-hand ends clockwise; twist right-hand ends counterclockwise.)

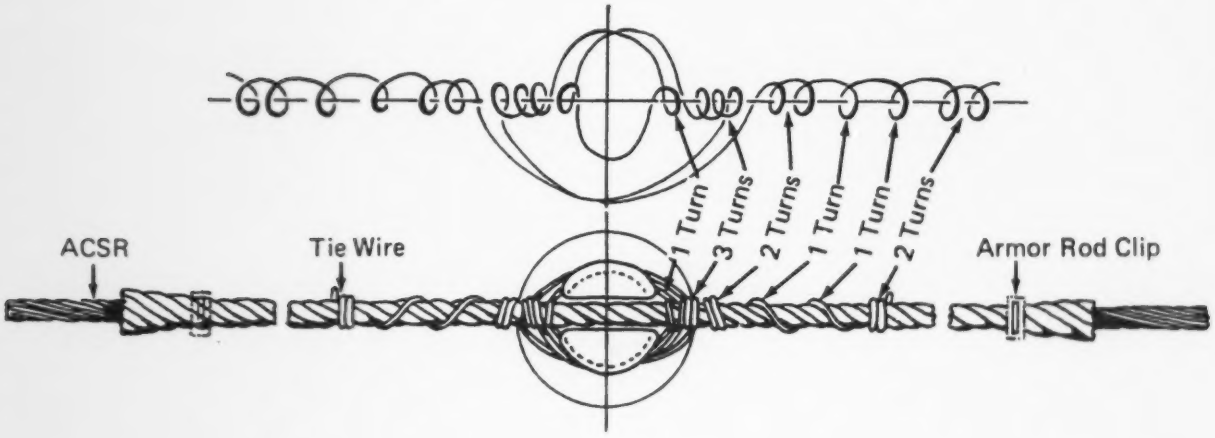
INFORMATION SHEET

2.



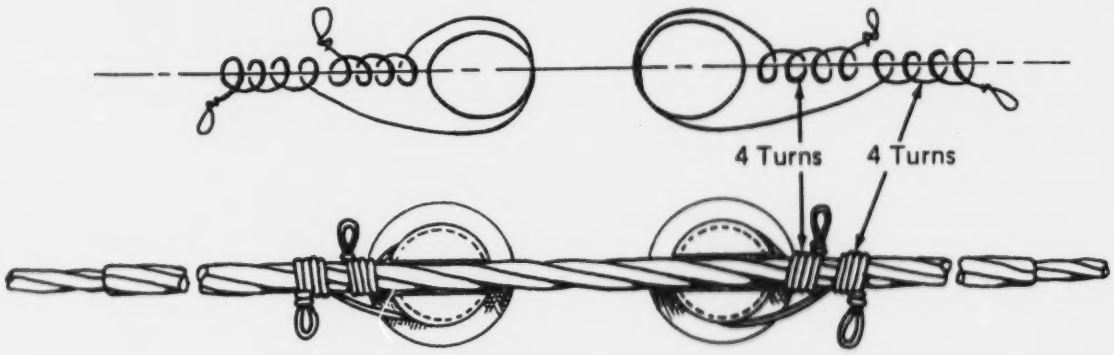
(NOTE: Tie wire assembly should be as tight as can be wrapped by hand. Ends should be twisted with pliers or hot line tools. Twist left-hand ends clockwise; twist right-hand ends counterclockwise.)

- ACSR conductor top groove double tie

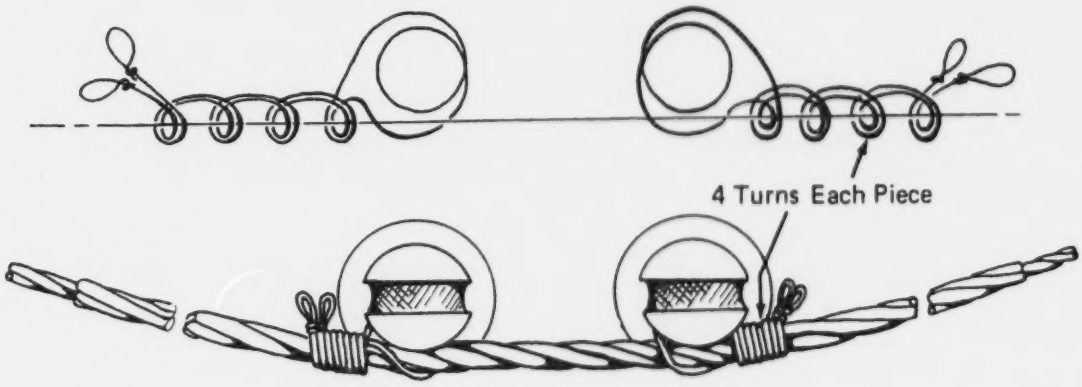


INFORMATION SHEET

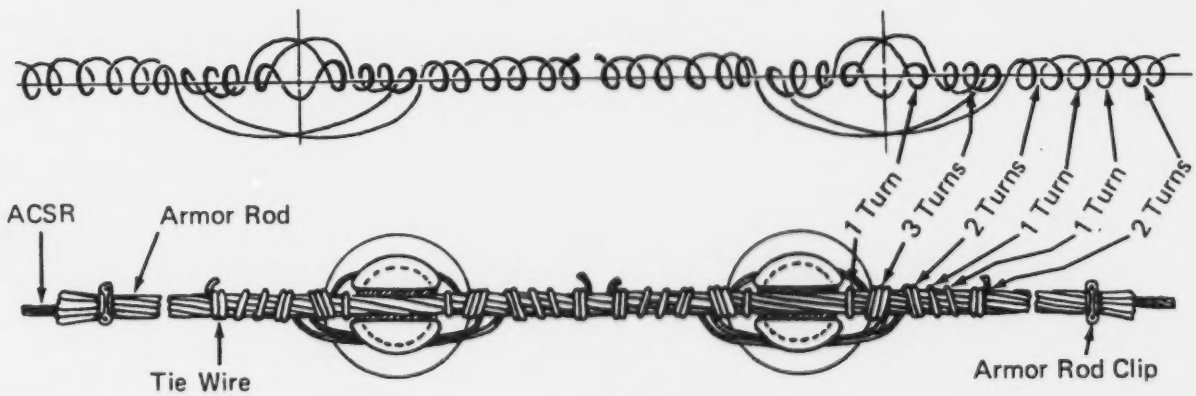
- ACSR conductor top groove double insulator hot line tie



- ACSR conductor side groove double insulator hot line tie



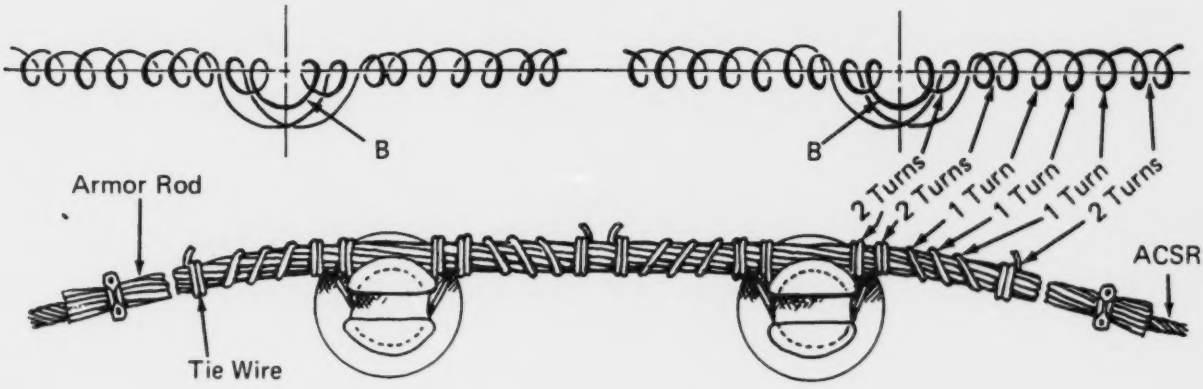
- ACSR conductor top groove double insulator double tie



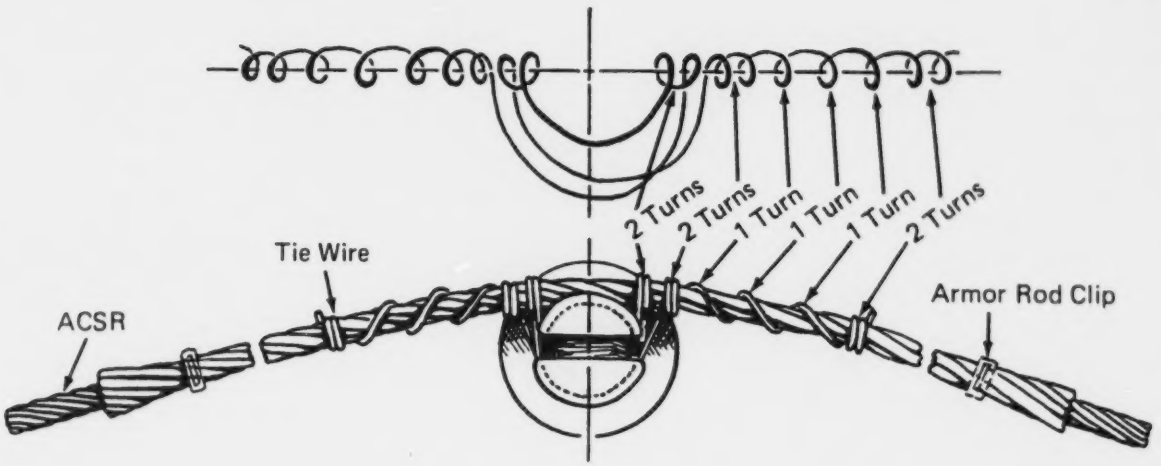
INFORMATION SHEET

- ACSR conductor side groove double insulator double tie

(NOTE: In making ties, start with middle of tie wire at position marked "B". To complete tie, cinch up the last two turns at each end with pliers until tie wire is tight. Use the flat face of the pliers against the armor rods.)

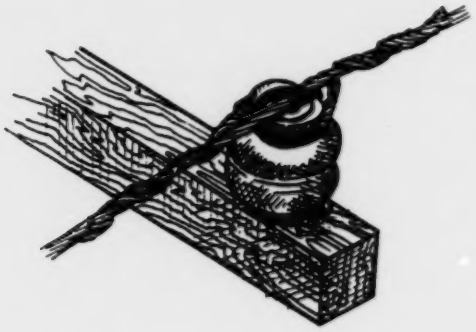


- ACSR conductor side groove tie

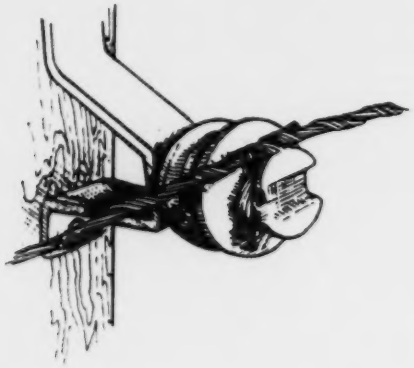


INFORMATION SHEET

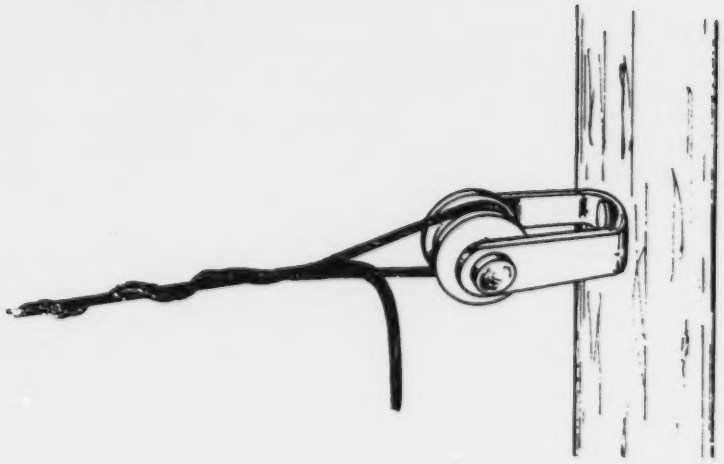
- ACSR conductor top groove preformed tie



- ACSR conductor side groove preformed tie

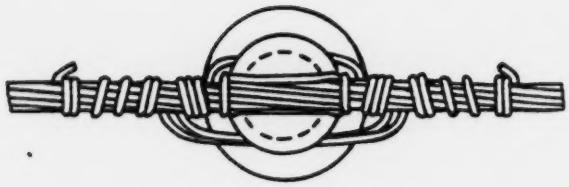


- Dead end tie



INFORMATION SHEET

- Top tie



8. Match types of conductors to their specific use.
   - ACSR — Primary and secondary
   - Copperweld copper — Primary and secondary
   - Hard-drawn copper — Primary and secondary
   - Soft-draw copper — Pole ground, tie wire, and jumper
   - Weatherproof — Secondary and service
9. State conductor clearance from ground, roofs and building walls for conductors carrying 750 volts or less. (Transparency 2)
   - 12 feet over sidewalks or platforms from which the conductor may be reached
   - 12 feet over residential driveways and commercial areas not subject to truck traffic
   - 16 feet over commercial parking lots and agricultural areas not subject to truck traffic
   - 16 feet over public streets, alleys, and driveways other than residential which are subject to truck traffic and over roofs accessible to vehicular traffic
   - 24 feet over track rails of railroads
   - 5 feet to building walls, projections, windows, balconies and areas readily accessible to pedestrians

INFORMATION SHEET

10. State conductor clearance from ground for conductors carrying over 750 volts to 22,000 volts. (Transparency 3)

- 26.5 feet over track rails of railroads
- 18.5 feet over roads, streets, alleys and parking lots subject to truck traffic
- 18.5 feet over farm land, pasture, forest and orchards
- 14.5 feet over spaces and ways accessible to pedestrians or restricted traffic only
- 7.5 feet to building walls, projections, windows, balconies and areas readily accessible to pedestrians

11. Match current-carrying capacities of various ACSR conductors to the correct conductor size.

Conductor Size	Current-Carrying Capacity (Amperes)
#4	130
#2	175
#1	200
#1/0	230
#2/0	265
#3/0	310
#4/0	350
266.8 kcmil	410 to 440
336.4 kcmil	500 to 515
397.5 kcmil	555 to 575
477 kcmil	625
556.5 kcmil	690 to 710
605 kcmil	740 to 750
636 kcmil	745 to 775

INFORMATION SHEET

12. Match current-carrying capacities of various copperweld copper conductors to the correct conductor size.

Conductor Size	Current-Carrying Capacity (In Amperes)
8A	100
6A	140
4A	180
2F	230
1/0F	310
3/0F	410

CONDUCTORS
UNIT 2

JOB SHEET 1

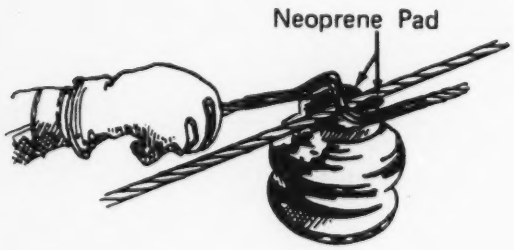
OBJECTIVE 13 — INSTALL A PREFORMED LINE TIE ON ACSR CONDUCTOR ON A DE-ENERGIZED CIRCUIT.

1. Tools and equipment

   - ACSR conductor fixed in a taut position
   - Line insulator with support
   - Performed line tie for size of ACSR conductor being used

2. Procedure

   - Place neoprene pad under conductor in center of top groove of insulator
   - Place the center of the tie across the top of insulator with the end of the tie parallel to the conductor

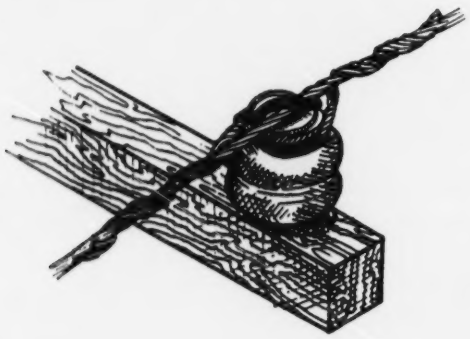


JOB SHEET 1

- Rotate the tie around the insulator until one end of the tie is around the neck of the insulator and wrapped onto the conductor

(NOTE: It is important to rotate and wrap, not bend and form tie.)

- Complete the tie by wrapping both ends of the tie onto the conductor and snapping the ends into place



CONDUCTORS
UNIT 2

JOB SHEET 2

OBJECTIVE 14 — INSTALL A TOP GROOVE CONDUCTOR TIE ON A DE-ENERGIZED COPPER CONDUCTOR.

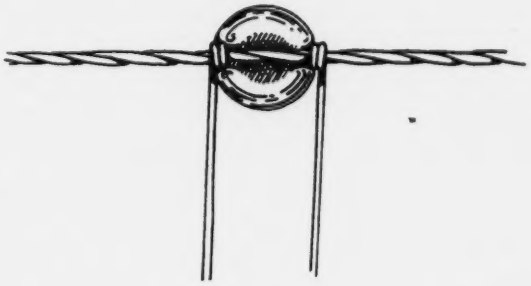
1. Tools and equipment

   - Copper conductor fixed in a taut position
   - Line insulator with support
   - Length of annealed copper tie wire

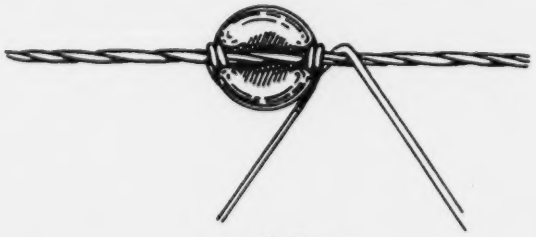
2. Procedure

   - Bend tie wire of proper size and length around neck of insulator under the conductor

   - Hold tie wire tightly around insulator neck and make two close, tight wraps around conductor

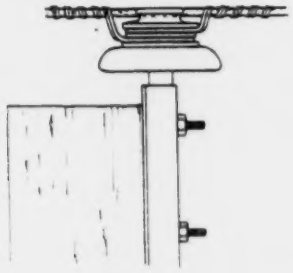


   - Cross ends of tie wire around the insulator and under the conductor



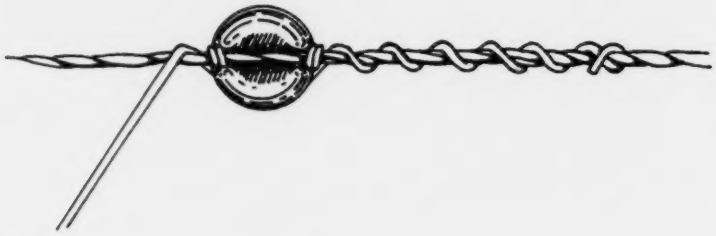
JOB SHEET 2

- Side View — Do not lap tie wire



- Wrap each end of the tie wire onto conductor snugly at a 45° angle

- Wrap six wraps at 45° angle on each side of insulator



CONDUCTORS
UNIT 2

JOB SHEET 3

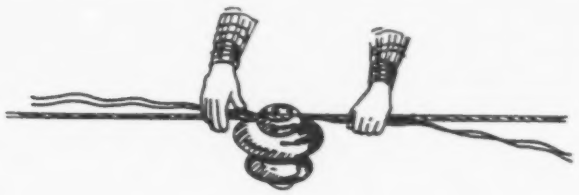
OBJECTIVE 15 — INSTALL A PREFORMED ARMOR ROD ON ACSR CONDUCTOR.

1. Tools and equipment

   - ACSR conductor fixed in a taut position
   - Line insulator with support
   - Armor rod sized to the ACSR conductor being used

2. Procedure.

   - Place two strands of armor rod around conductor with center of armor rod at the center of the insulator



   - Place two or three strands at a time around the conductor until the full set of strands are in place

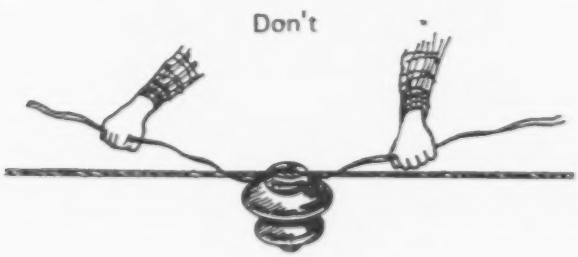
JOB SHEET 3

- Rotate your hands around the armor rod with a rolling motion

  (NOTE: Roll one hand away from yourself and the other hand toward yourself, letting the armor rod wrap onto the conductor from the center outward.)

- Continue rotating the rods until the full length has rolled onto the conductor and the ends are snapped into place

(CAUTION: Do not force strands into place. Preformed rods cannot be installed properly if any of the strands are bent.)



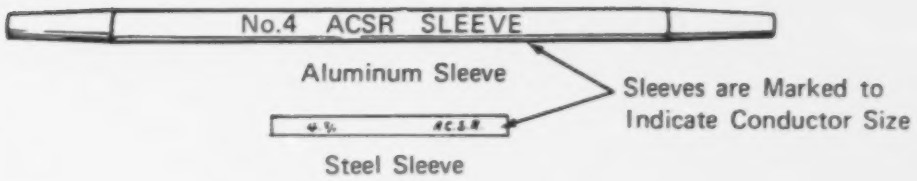
CONDUCTORS
UNIT 2

JOB SHEET 4

OBJECTIVE 16 — JOIN ACSR CONDUCTOR.

1. Tools and equipment

   - Length of ACSR conductor
   - Hammer
   - Manual or hydraulic crimping tool
   - Conductor brush
   - Sleeve sized to conductor being used



2. Procedure

   - Select proper crimping tool according to recommendations of sleeve manufacturer

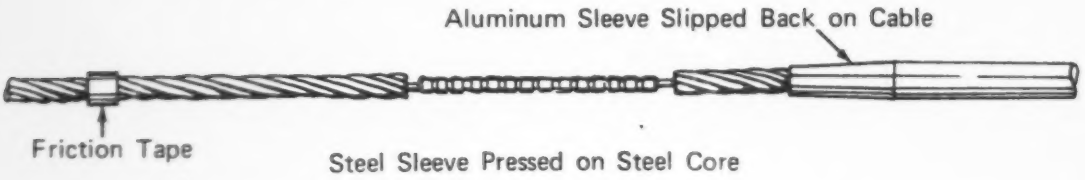
     (NOTE: Make sure tool is adjusted and the right ties are in tool.)

   - Remove aluminum strands from steel core the distance recommended by splice manufacturer

ACSR Ready for Splicing

JOB SHEET 4

- Clean conductor with conductor brush
- Slide conductor sleeve onto conductor
- Install and crimp core sleeve



- Slide center of conductor sleeve to center of core sleeve and crimp from the center toward the ends

Completed Splice

- Straighten splice by hammering carefully against a suitable wood block

GROUNDING AND CONNECTING
UNIT 3

UNIT OBJECTIVE

After completion of this unit, the student should be able to state the procedure for installing temporary protective grounds and arrange in order the steps to follow when disconnecting and grounding a sectionalizer or recloser station and a multi-phase vertical corner. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms commonly associated with grounds and connectors to the correct definitions.
2. State the purposes of grounding.
3. List methods of grounding.
4. Select from a list those elements necessary for good grounding.
5. Select from a list equipment which must be grounded.
6. State the correct procedure for installing temporary protective grounds.
7. Arrange in order the steps to follow when disconnecting and grounding at sectionalizer or recloser station.
8. Arrange in order the steps to follow when disconnecting and grounding at multi-phase vertical corner.
9. State the procedure for installing temporary protective grounds at air-break switch on a transmission line.
10. List elements of a good connection.

GROUNDING AND CONNECTING
UNIT 3

INFORMATION SHEET

1. Match terms commonly associated with grounds and connectors to the correct definitions.

   - Mobile equipment grounding — Installing a driven ground or connecting equipment to an existing ground (Transparency 1)
   - Line grounding — Connecting the line neutral to the pole ground (Transparency 2)
   - Equipment grounding — Connecting the tank, frame, or housing of equipment to a ground
   - Protective ground — Ground installed to protect persons which may come in contact with equipment
   - "Swinging" ground — Ground on a primary circuit which is irregular
   - "Light" ground — Ground which has poor contact or high resistance to earth
   - "Solid" ground — Ground which has little resistance between the circuit and earth
   - Inhibitor — Substance used on conductors to prevent oxidation or corrosion and to help make a better connection
   - Ground resistance — Resistance caused by poor connection or poor soil condition
   - Temporary ground — Ground installed by a line technician for personal protection (Transparency 3)
   - Hold card — Tag placed at disconnect point to prevent someone else from re-energizing line (Transparency 2)

     (NOTE: The person who installs the hold card should be the one to remove it.)
   - Running ground — Ground used on conductor being pulled (Transparency 3)
   - Equal-potential grounding — A cluster block on a wood pole structure below the work area connected to the grounding conductor (Transparency 4)
   - Cluster bracket — Apparatus used to hang grounding sets on the pole to facilitate lifting clamps, one at a time to the conductors (Transparency 5)

     (NOTE: Use approved grounding clamps for grounding, NOT hot line clamps.)

INFORMATION SHEET

2. State the purposes of grounding.

   - Prevent injury to persons
   - Protect lines and equipment from lightning
   - Drain off unwanted voltage and current

   Examples: Induced voltage, lightning

3. List methods of grounding.

   - Driven rod
   - Screw-in rod
   - Coil or plate fastened to bottom of pole
   - Buried metal mat

4. Select from a list those elements necessary for good grounding.

   - Contact with moist soil
   - Metal construction that resists corrosion
   - Capacity for maximum current surges
   - Low resistance to earth

   (NOTE: Grounding cables must be #2 AWG copper or equivalent. Larger conductors will require large grounding cable. Mechanical jumpers are not grounding sets.)

5. Select from a list equipment which must be grounded.

   - Mobile equipment working near energized lines
   - Lightning arrester
   - Voltage regulator tank
   - Transformer tank
   - Transformer platform
   - Guy wire
   - Capacitor rack

INFORMATION SHEET

- Current and potential transformers
- Hand-operated switch gear
- Metal pole
- Metal conduit
- Metering equipment
- Switch box
- Cable sheath
- Motor casing

6. State the correct procedure for installing temporary protective grounds. (Transparency 6)

   (NOTE: Receive clearance from dispatcher before disconnecting any line.)

   - Disconnect line jumper and fasten it back on itself
   - Test line for potential
   - Attach one end of grounding cable to neutral

     (NOTE: Always use hot stick to install or remove grounding cables.)

   - Attach other end of grounding cable to phase wire
   - Attach hold card
   - Install grounds within sight on both sides of work area on all conductors

     (NOTE: Always use a hot stick to disconnect and ground a circuit.)

7. Arrange in order the steps to follow when disconnecting and grounding at sectionalizer or recloser station. (Transparency 7)

   - Move operating handle to Off position with hot stick
   - Remove source side jumper and fasten it back on itself
   - Remove load side jumper and fasten it back on itself or on the neutral
   - Attach ground cable to neutral on load side and then to phase wire on load side
   - Attach hold card

INFORMATION SHEET

(NOTE: Notify the dispatcher before any line is disconnected.)

8. Arrange in order the steps to follow when disconnecting and grounding at multi-phase vertical corner. (Transparency 8)

   - Disconnect all phases, starting with the bottom phase and going upward, and fasten each jumper back on its own line
   - Attach ground cable to neutral wire and then to bottom phase wire
   - Attach ground cable to bottom phase and connect to center phase
   - Attach ground cable to center phase and connect to top phase
   - Attach hold card

   (NOTE: A 12-foot hot stick is required to disconnect and ground a multi-phase vertical corner.)

   (**CAUTION: The source side of the line will still be energized**.)

9. State the procedure for installing temporary protective grounds at air-break switch on a transmission line. (Transparency 9)

   (NOTE: Clearance from the dispatcher must be obtained before switch is opened.)

   - Open switch

     (NOTE: Wear rubber gloves and keep both feet on the grounding platform plate—touch and step potential protection. Use a quick, sure motion when opening switch. Do not hesitate after switch has started to open.)

   - Check switch blades visually to see that they are open
   - Lock switch open
   - Connect ground cable to driven or system neutral or screw-in ground rod if accessible

     (NOTE: Install and remove with rubber gloves, sleeves and live line tool.)

   - Attach ground cable to center phase wire on load side of switch
   - Connect short ground cables to center grounded phase and to both outside phase wires

     (NOTE: Always connect grounding cables to neutral or ground rod first.)

INFORMATION SHEET

10. List elements of a good connection.

- Connector sized to conductor being connected
- Clean conductor
- Proper connector for type of conductor

  Examples: Copper to copper, aluminum to aluminum, copper to aluminum

  (NOTE: Connectors will indicate what type of conductor they are used for by stating *cu-al* for copper to aluminum, *cu-cu* for copper to copper, and *al-al* for aluminum to aluminum.)

- Inhibitor applied to conductor

GENERATORS AND BATTERIES
UNIT 4

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify various circuits and connect batteries in series and parallel. The student should be able to use precautions when connecting batteries. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with generators and batteries to the correct definitions.
2. List kinds of generating plants.
3. Match kinds of generators to the voltages produced by each.
4. Match kinds of generators to the specific uses.
5. Calculate the frequency (Hertz) of various generators.
6. List precautions to observe with the use of portable generators.
7. List types and kinds of voltage-producing cells.
8. Identify various circuits of connected batteries.
9. Select from a list precautions to observe when connecting batteries.
10. Arrange in order the steps to follow to connect lead-acid batteries when starting equipment.
11. Connect batteries in series and parallel. (Assignment Sheet 1)

GENERATORS AND BATTERIES
UNIT 4

INFORMATION SHEET

1. Match the terms associated with generators and batteries to the correct definitions.

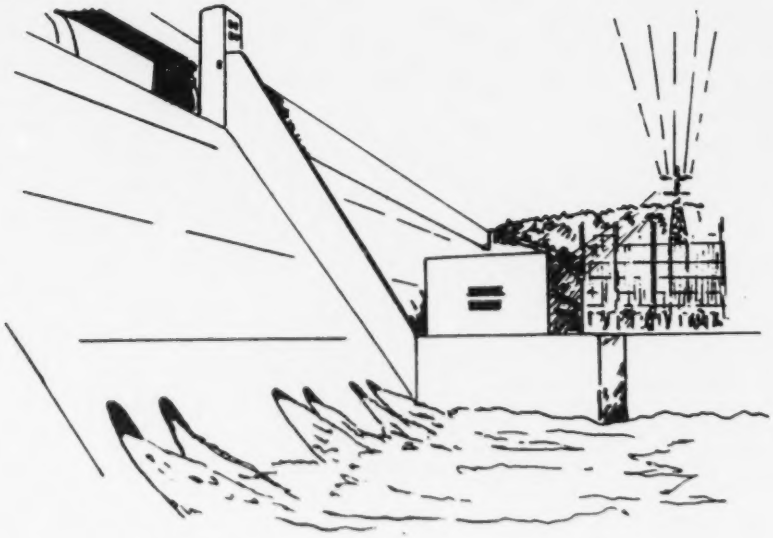
   - Hydroelectric power — Electrical power generated by using flowing water to turn generators
   - Steam plant — Generation plant powered by steam created by oil, coal, or natural gas heat
   - Atomic plant — Generation plant powered by steam created by atomic energy
   - Diesel plant — Generation plant powered by a diesel-fueled engine
   - Alternator — Alternating current generator which produces current by rotating a magnetic field close to stator coil (Transparency 1)
   - Polyphase alternator — Alternator which produces four or more voltage peaks at different intervals in time in one cycle (Transparency 2)

     (NOTE: The standard polyphase alternator in use today produces six peaks, which is three-phase power.)
   - Electrolyte — Sulfuric acid used in lead-acid storage batteries
   - Specific gravity — Weight of electrolyte as compared to water
   - Hydrometer — Instrument used to measure the specific gravity of electrolyte in a lead-acid storage battery (Transparency 3)
   - Primary cell — Electricity-producing cell which is of no value when the electrical activity is exhausted
   - Secondary cell — Electricity-producing cell which can be restored to activity by passing a current through it in a reverse direction
   - Rectifier — Device which converts alternating current to direct current
   - Generator — Machine that converts mechanical energy to electrical energy
   - Battery — Two or more primary or secondary cells connected electrically

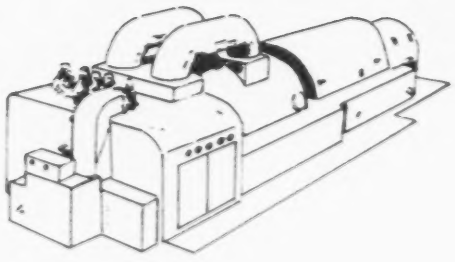
INFORMATION SHEET

2. List kinds of generating plants.

- Hydroelectric

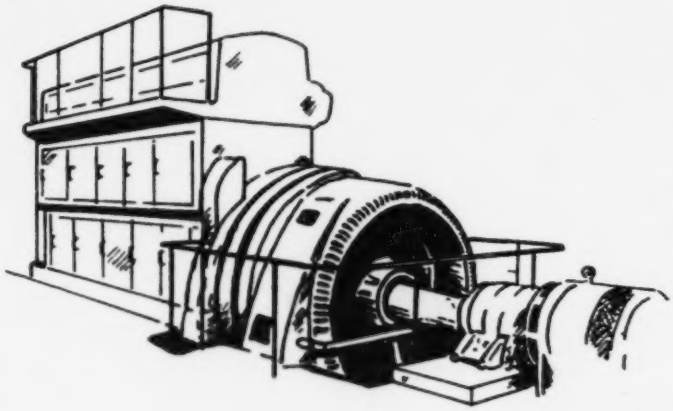


- Steam-powered



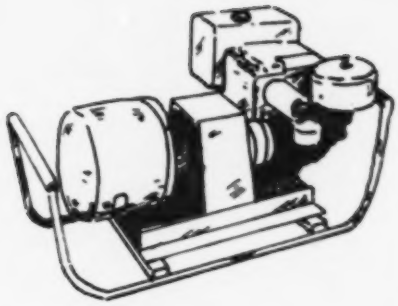
INFORMATION SHEET

- Diesel-powered



- Gasoline-powered

1. Portable



2. Mobile or stationary

3. Match kinds of generators to the voltages produced by each.

- Steam and hydroelectric plants — 13,800 to 18,000 volts
- Diesel-powered plant — 1600 to 2400 volts
- Gasoline-powered portable generator — 120 to 480 volts

INFORMATION SHEET

4. Match kinds of generators to the specific uses.

   - Hydroelectric or steam plant — Supplies power to large areas
   - Diesel-powered plant — Supplies power to small towns or supplements larger plants during peak loads
   - Gasoline-powered mobile or stationary generator — Supplies emergency or standby power for farms and businesses
   - Gasoline-powered portable generator — Supplies temporary power for construction sites for power tools and lighting

5. Calculate the frequency (Hertz) of various generators.

   Formula: Frequency in cycles = $\frac{\text{No. of poles x rpm}}{120}$

   (NOTE: A cycle or Hertz is completed when the rotor passes two poles of opposite polarity.)

6. List precautions to observe with the use of portable generators.

   - Ground the generator housing

     (NOTE: All grounding must be tight — this is very important.)

   - Use of three-wire power cord with ground wire (120 V supply)
   - Check all standby generators for live connections

     (NOTE: A standby or emergency power generator must be equipped with a switch that will not allow the generator to energize the line which it is replacing because of an outage.)

   - Do not connect a generator to an energized line

7. List types and kinds of voltage-producing cells.

   - Primary cells
     1. Zinc-carbon
     2. Mercury-zinc
   - Secondary cells
     1. Lead-acid
     2. Nickel-cadmium

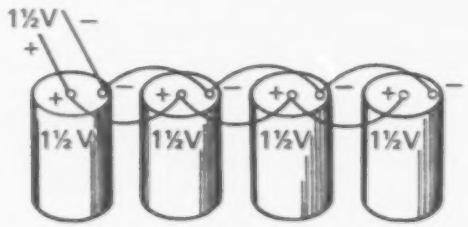
   (NOTE: Primary cells are of no value when exhausted; secondary cells may be recharged.)

INFORMATION SHEET

8. Identify various circuits of connected batteries.

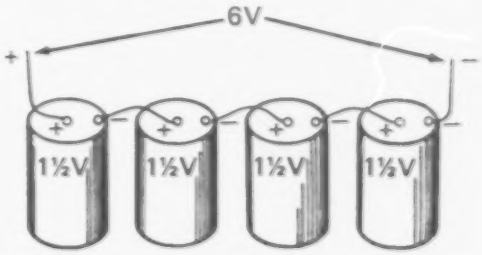
- Parallel connected — Positive (+) to positive and negative (-) to negative

  (NOTE: The voltage of parallel-connected batteries will be the same as if only one battery were used. The current output will be increased by the number of batteries used times the output of one battery.)

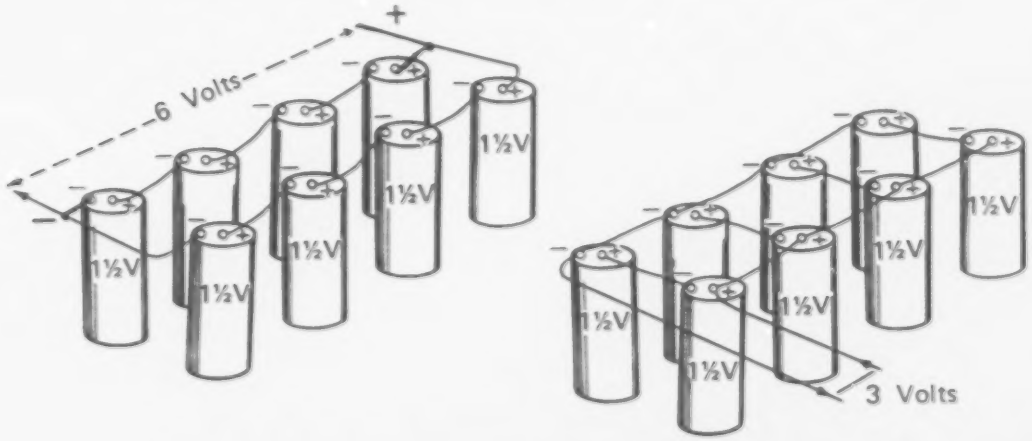


- Series connected — Negative (-) to positive (+)

  (NOTE: The voltage of series-connected batteries is the voltage of one battery times the number of batteries in the circuit.)



- Series-parallel connected — Negative (-) to positive (+) in the series; positive to positive and negative to negative in parallel



INFORMATION SHEET

9. Select from a list precautions to observe when connecting batteries.

   - Wear eye protection
   - Do not short-circuit a battery

     (NOTE: Jumper between positive and negative terminals.)
   - Do not series-connect batteries unless the voltage desired is more than the voltage of one battery
   - Do not allow sparks or open flame near a lead-acid battery
   - Study the Material Safety Data Sheet (MSDS) accompanying each battery

10. Arrange in order the steps to follow to connect lead-acid batteries when starting equipment. (Transparency 4)

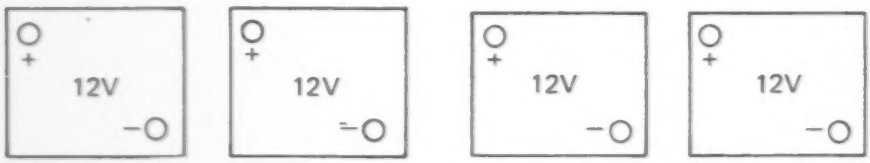
    - Connect first jumper to positive terminal of each battery
    - Connect second jumper to negative terminal of charged battery
    - Connect other end of second jumper to the frame of equipment being started

GENERATORS AND BATTERIES
UNIT 4

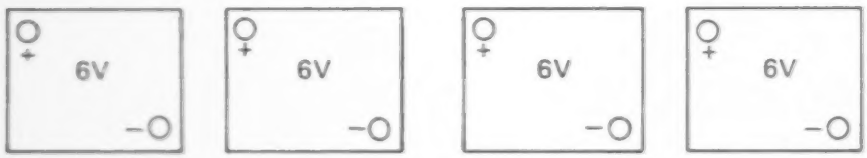
ASSIGNMENT SHEET 1

OBJECTIVE 11— CONNECT BATTERIES IN SERIES AND PARALLEL.

1. Draw in the lines between the batteries to connect them in series and state the voltage that will be produced.



2. Draw in the lines between the batteries to connect them in parallel and state the voltage that will be produced.



3. Draw in the lines between the three batteries on the right to connect them in series. Draw in the lines on the three batteries on the left to connect them in series. Draw lines between the group on the right and the group on the left to connect the two groups in parallel. State the voltage produced from the two groups.

WORK PROCEDURES
(NONENERGIZED)
UNIT 5

UNIT OBJECTIVE

After completion of this unit, the student should be able to arrange in order the procedure for line construction and be able to read a staking sheet. The student should be able to list materials needed to complete a work order and locate rural property using a legal description. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with work procedures to the correct definitions.
2. Select from a list information found on a staking sheet.
3. Arrange in proper order the procedure for line construction.
4. List steps to follow when installing service wire.
5. State the procedure for connecting service wire.
6. Match the materials needed to construct primary and neutral assemblies using ACSR conductor 7.2 kV construction.
7. List materials needed to install various pole ground assemblies.
8. List materials needed for various primary assemblies. (Assignment Sheet 1)
9. List materials needed to complete a work order. (Assignment Sheet 2)
10. Identify section numbers within a township. (Assignment Sheet 3)
11. Locate rural property in Oklahoma using legal descriptions. (Assignment Sheet 4)

WORK PROCEDURES
(NONENERGIZED)
UNIT 5

INFORMATION SHEET

1. Match the terms associated with work procedures to the correct definitions. (Transparencies 1-4)

   - Staking sheet — Shows materials needed, location, and sketch of work to be done (Transparency 5)
   - Ruling span — Average span plus two-thirds of the difference between the longest span and the average span
   - Guy lead — Distance between the pole to be guyed and the anchor
   - Township — Area six miles square which is divided into thirty-six sections (Transparency 1)
   - Section — Area one mile square (Transparency 1)
   - Quarter section — Area of a section one-half mile square (Transparency 1)
   - Range — Location of a township either east or west of a principal meridian (Transparency 2)
   - Meridian — Line running north and south through the state every twenty-four miles (Transparency 2)
   - Principal meridian — Meridian which divides the east and west halves of the state (Transparency 4)
   - Indian Meridian — Principal meridian in Oklahoma (Transparency 4)
   - Legal description — Location of property according to township, range, section, and quarter section
   - Section line — Line set at one mile intervals which runs both east and west and north and south through the state (Transparency 1)
   - Range line — Line which runs east and west through the state every six miles (Transparency 2)
   - Check — Area twenty-four miles square which contains sixteen townships (Transparency 3)
   - Parallel — Line which runs east and west through the state every twenty-four miles (Transparency 2)

INFORMATION SHEET

- Specification book — Materials and methods of line construction recommended by the Rural Electrification Administration (REA)

- Base line — Parallel in the southern part of the state; the south boundary of the Oklahoma panhandle counties from which ranges are measured (Transparencies 4 and 6)

  (NOTE: Oklahoma is shown as an example. Students should use maps for their specific region. The base line in Oklahoma runs through Duncan and Sulphur.)

- Account number — Designation given a meter location which indicates the location according to a legal description

  Example: 30-124-015

  30 is the number given a particular township by the organizations. **12** is the section number in township 30. **4** is the quarter section in section 12. **015** is the specific location in quarter section 4.

  (NOTE: A line technician may be asked any of this information by the One-Call System in his/her state.)

2. Select from a list information found on a staking sheet.

   (NOTE: Staking sheets differ in design from one organization to another, but the information shown is basically the same.)

   - Location

     1. Range
     2. Township
     3. Section
     4. Approximate location in section

   - Sketch of line

     1. Take-off pole
     2. Direction to build line
     3. Dead-end pole
     4. Service location

   - Pole numbers

INFORMATION SHEET

- Span lengths
  1. Primary line
  2. Secondary line
  3. Service line
  4. Total length of line
- Heights and classes of poles
- Primary assemblies
- Size and type of primary conductor
- Right-of-way to be cleared
- Transformer type and size
- Grounding assemblies
- Types and sizes of guys and anchors
- Service size and length
- Secondary assemblies
- Miscellaneous assemblies

  Examples: Meter loop, guy guard, armor rod
- Size and type of meter
- Recap of all materials needed

(NOTE: Any changes made in the job construction should be noted on the staking sheet.)

3. Arrange in proper order the procedure for line construction.
   - Document tailgate discussion
   - Inspect vehicle
   - Get job assignment
   - Read staking sheets

INFORMATION SHEET

- Gather materials

  Examples: Poles, crossarms, hardware, conductor, transformers

- Load poles and conductor

  (NOTE: When loading poles, arrange the loading so that the poles to be unloaded first are on top.)

- Haul and place poles near line stakes

  (NOTE: Place poles so they will not obstruct the path of hole digging and pole setting equipment.)

- Frame poles

  (NOTE: Install all hardware, crossarms, and pole grounds according to REA specifications for the unit being framed.)

- Dig holes for poles and anchors

- Set and tamp poles and anchors

  (NOTE: Poles and anchors should be well tamped. Poles should be banked with eight to ten inches of backfill.)

- Pull and make up guys

  (NOTE: Install guy markers.)

- String conductor along pole line

  (NOTE: Keep conductors separated when stringing to avoid tangling.)

- Lay up conductor, sag, and tie in

  (NOTE: If line being built takes off from an energized pole, dead-end and ground conductor on energized pole before pulling wire to sag from other end of line.)

- Hang transformers

  (NOTE: Record information from transformer nameplate.)

- Connect grounds and service wire

- Remove ground cables and energize line

- Check voltage at meter base

INFORMATION SHEET

- Set meter and record information
- Sign or initial staking sheet

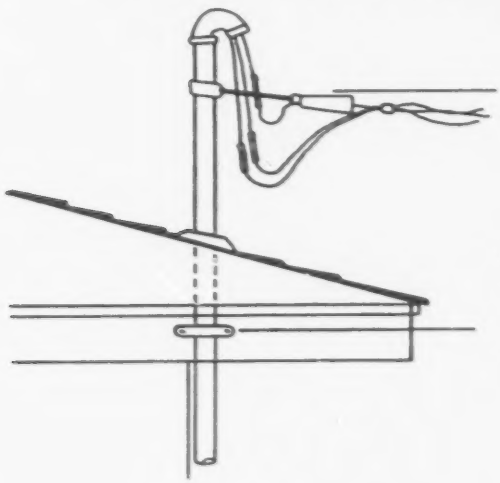
(NOTE: Pick up any wire or trash before leaving.)

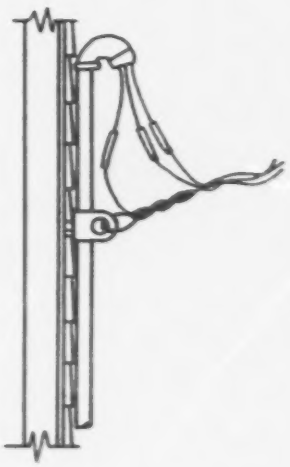
4. List steps to follow when installing service wire.

(NOTE: Service wire should never be pulled on a hot pole. Secure end on hot pole and pull service wire on meter pole or house.)

- Attach service to house or building and connect service to consumer's meter loop

(NOTE: See current edition of *National Electrical Code* for clearances.)

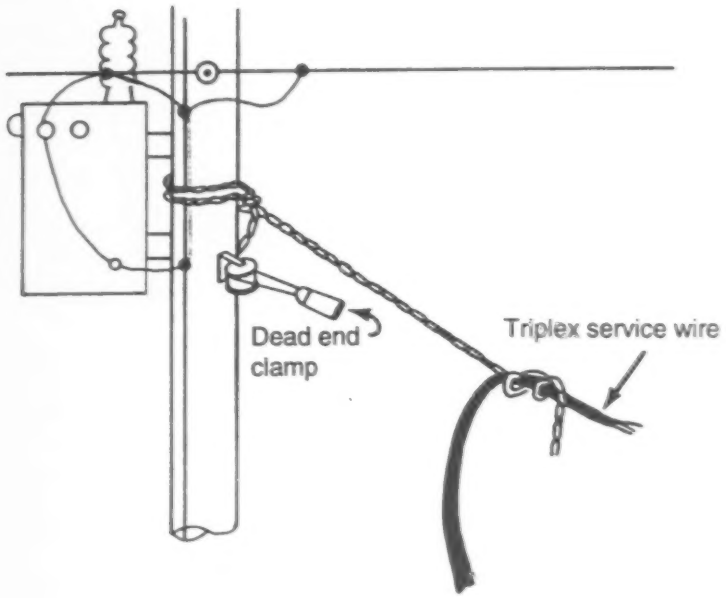




- Pull service wire from transformer pole

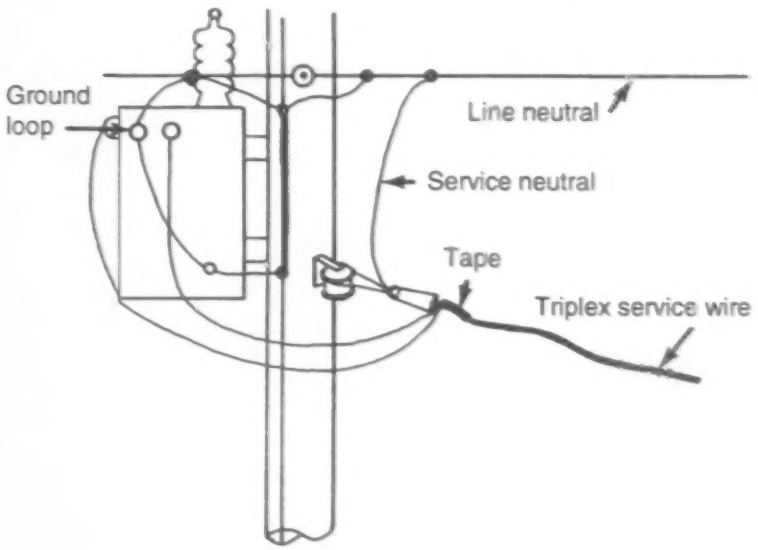
(NOTE: If service is to be connected to a meter pole, a handline should be used to pull service wire to sag on the meter pole.)

INFORMATION SHEET



(CAUTION: Service wire should be cut as close to needed length as possible. A long wire end could flop into an energized line.)

- Place neutral wire in dead-end clamp and adjust service wire to proper sag



INFORMATION SHEET

- Connect service neutral to line neutral
- Connect insulated service conductors to transformer lugs

(NOTE: Be sure the tank and secondary bushing lugs are tight and that a good ground has been made on the transformer ground loop.)

5. State the procedure for connecting service wire.

- Use connector suitable for type of conductors being connected

(NOTE: Use compression type connectors when possible.)

- Connect grounding conductors before connecting current-carrying conductors

(NOTE: This is very important.)

- Remove enough insulation to prevent connector from overlapping insulation

(NOTE: When a connector is placed over a fragment of insulation, a poor connection will result.)

- Use inhibitor on all aluminum or aluminum to copper connections

6. Match the materials needed to construct primary and neutral assemblies using ACSR conductor 7.2 kV construction.

- A1

1. Pin type insulator
2. Spool insulator
3. 20" pole top pin
4. Single upset bolt
5. 5/8" machine bolts
6. 2 1/4" square washers
7. Locknuts

- A1-1

1. Pin type insulators
2. Spool insulator

INFORMATION SHEET

3. 20" pole top pins
4. Single upset bolt
5. 5/8" machine bolts
6. 3/4" x 1 1/2" pipe spacers
7. 2 1/4" square washers
8. Locknuts

- A3

1. 2 1/4" square washers
2. Suspension insulators
3. 5/8" eye bolts
4. Anchor shackle
5. Primary angle assembly
6. Neutral angle assembly

- A5

1. 2 1/4" square washers
2. Suspension insulators
3. 5/8" eye bolt
4. Primary dead-end assembly
5. Neutral dead-end assembly
6. Locknuts

- A5-2

1. 2 1/4" square washers
2. Suspension insulator
3. 5/8" eye bolt
4. Connectors

INFORMATION SHEET

5. 5/8" eye nut
6. Jumper
7. Primary dead-end assembly
8. Neutral dead-end assembly
9. Anchor shackle
10. Locknuts

- Primary dead-end assembly
  1. Dead-end clamp
  2. Armor tape

     (NOTE: Armor tape is not required if dead-end clamp is aluminum or has an aluminum liner.)

- Neutral dead-end assembly
  1. Swinging secondary clevis
  2. Spool insulator
  3. Loop dead-end clamp
  4. Armor tape

- Neutral angle assembly
  1. Swinging secondary clevis
  2. Spool insulator

7. List materials needed to install various pole ground assemblies.

- M2-2
  1. No. 6 or equivalent soft-drawn copper
  2. Connectors
  3. Steeples
  4. Butt plate or butt wrap
  5. Galvanized nails for butt plate

INFORMATION SHEET

- M2-1

  1. No. 6 or equivalent soft-drawn copper
  2. Connectors
  3. Steeples
  4. Ground rod
  5. Ground rod clamp

- VM2-12

  1. No. 6 or equivalent soft-drawn copper
  2. Connectors
  3. Staples
  4. Butt plate or butt wrap
  5. Galvanized nails for butt plate

  (NOTE: On 14.4 kV structures the ground wire does not extend above the neutral.)

WORK PROCEDURES
(NONENERGIZED)
UNIT 5

ASSIGNMENT SHEET 1

OBJECTIVE 8 — LIST MATERIALS NEEDED FOR VARIOUS PRIMARY ASSEMBLIES.

List the amount and type of hardware required to construct the following units. Use the specifications for 7.2/12.5 kV line construction.

1.		AMOUNT	TYPE
A1			
a.	Bolts	_____	_____
b.	Insulators	_____	_____
c.	Insulators	_____	_____
d.	Washers	_____	_____
e.	Nuts	_____	_____
f.	Bolts	_____	_____
g.	Pins	_____	_____

2.			
A1-1			
a.	Bolts	_____	_____
b.	Insulators	_____	_____
c.	Insulators	_____	_____
d.	Washers	_____	_____
e.	Nuts	_____	_____
f.	Bolts	_____	_____
g.	Pins	_____	_____
h.	Spacers	_____	_____

ASSIGNMENT SHEET 1

3.		AMOUNT	TYPE
	A3		
	a. Bolts	_____	_____
	b. Insulators	_____	_____
	c. Insulators	_____	_____
	d. Washers	_____	_____
	e. Nuts	_____	_____
	f. Shackle	_____	_____
	g. Assembly	_____	_____
	h. Assembly	_____	_____
4.			
	A5		
	a. Bolts	_____	_____
	b. Insulators	_____	_____
	c. Insulators	_____	_____
	d. Washers	_____	_____
	e. Nuts	_____	_____
	f. Assembly	_____	_____
	g. Assembly	_____	_____

WORK PROCEDURES
(NONENERGIZED)
UNIT 5

ASSIGNMENT SHEET 2

OBJECTIVE 9 — LIST MATERIALS NEEDED TO COMPLETE A WORK ORDER.

Use the staking sheet to compile and list all materials needed to construct the work order.

1. Poles

Number	Size (length) and Class
_____	_____
_____	_____
_____	_____

2. Primary assemblies

Number	Unit
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

3. Pole grounds

Number	Unit
_____	_____
_____	_____

Approximate total feet ground wire _____

Number of ground rods and clamps _____

4. Primary conductor

Type	Feet
_____	_____

ASSIGNMENT SHEET 2

5. Service conductor

Type	Feet
_____	_____

6. Service assemblies

Number	Unit
_____	_____

7. Guys

Number	Unit
_____	_____

8. Anchors

Number	Unit
_____	_____

9. Armor rods

Number
_____

10. Connectors

Number
_____

11. Miscellaneous assemblies

Number	Unit
_____	_____

STAKING SHEET

COSMO ELECTRIC COOPERATIVE

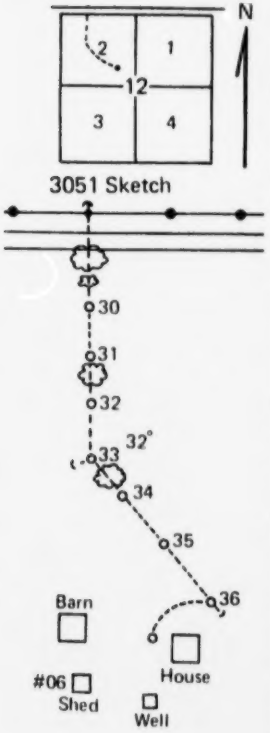
Member Joe Dokes

Work Order No 1532

Account No 30-122-015

Sheet No 1 of 1 Sheets County Custer Township 2N Range 18W Section 12

Date Staked 7-3-95 County Custer



(A) Pole No.	(B) Span	(C) Pole H&C	(D) Pv 1 Assm	(E) Cond	(F) R/W	(G) Trans	(H) Gvnd Assm	(I) Guy-1 Anchor	(J) Sec Assm	(K) Serv	(L) Misc Assm	(M) Recap	
3051		EX 35-5	A-5-2	#4 ACSR				E1-2 F1-2				35-5	2
30	340	35-6	A-1-1		100' R120		M2-2					35-6	5
31	330	35-6	A-1				M2-2					30-6	1
32	340	35-6	A-1		60' R120		M2-1					A-1	4
33	300	35-5	A-3				M2-2	E-1 F1-2				A-1-1	1
34	300	35-6	A-1		50' R120		M2-2					A-3	1
35	270	35-6	A-1				M2-2					A-5	1
36	330	35-5	A-5			6106 25	M2-1	F1-2		K-14		A5-2	1
												M2-2	5
MP		30-6					M2-1			60' K-14 # 2TPX	M8-9	M2-1	3
												E1-2	3
												F1-2	3
												#2TPX	60'
												#4 ACSR	4,420
												M8-9	1
												K-14	2
	2210												

Staked by Jim Const. Started 7-7-95 Const. Completed 7-7-95

Const. Completed by D.D. Remarks Right of way cleared by CMC 7-4-95

ASSIGNMENT SHEET 2

PLT C - 5 - 17

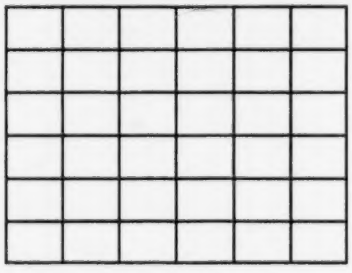
WORK PROCEDURES
(NONENERGIZED)
UNIT 5

ASSIGNMENT SHEET 3

OBJECTIVE 10 — IDENTIFY SECTION NUMBERS WITHIN A TOWNSHIP.

Answer the following problems relating to the numbering of sections.

1. Number the sections within the township drawn below.



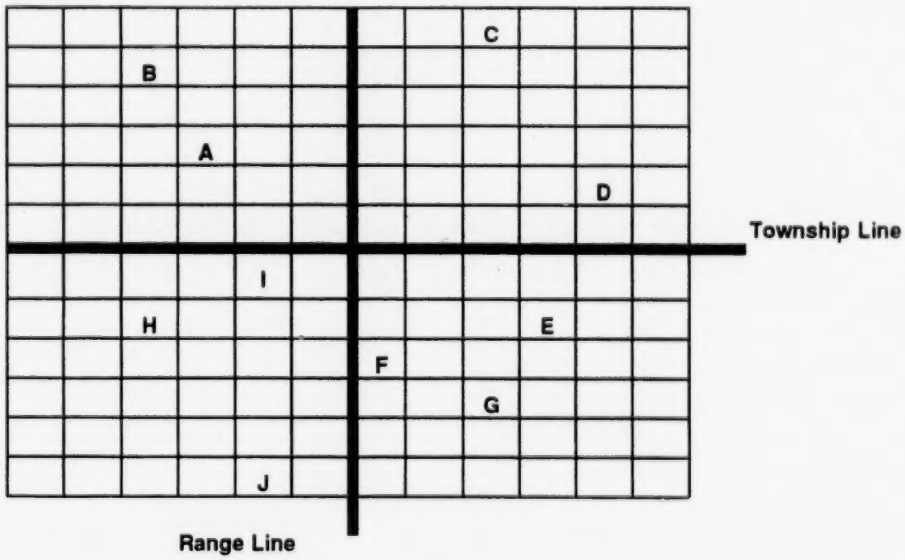
2. List the section numbers of each letter on the townships shown below.

a. _____ e. _____ i. _____

b. _____ f. _____ j. _____

c. _____ g. _____

d. _____ h. _____



WORK PROCEDURES
(NONENERGIZED)
UNIT 5

ASSIGNMENT SHEET 4

OBJECTIVE 11 — LOCATE RURAL PROPERTY IN OKLAHOMA USING LEGAL DESCRIPTIONS.

Use the map on the following page to answer the questions below.

1. What is located on the following property?

   a. SEC. 20 T6N R19W _____

   b. SEC. 36 T6N R21W _____

   c. SEC. 18 T6N R19W _____

2. What is the legal description for the following listed names?

   a. Cambridge _____

   b. Barton's Store _____

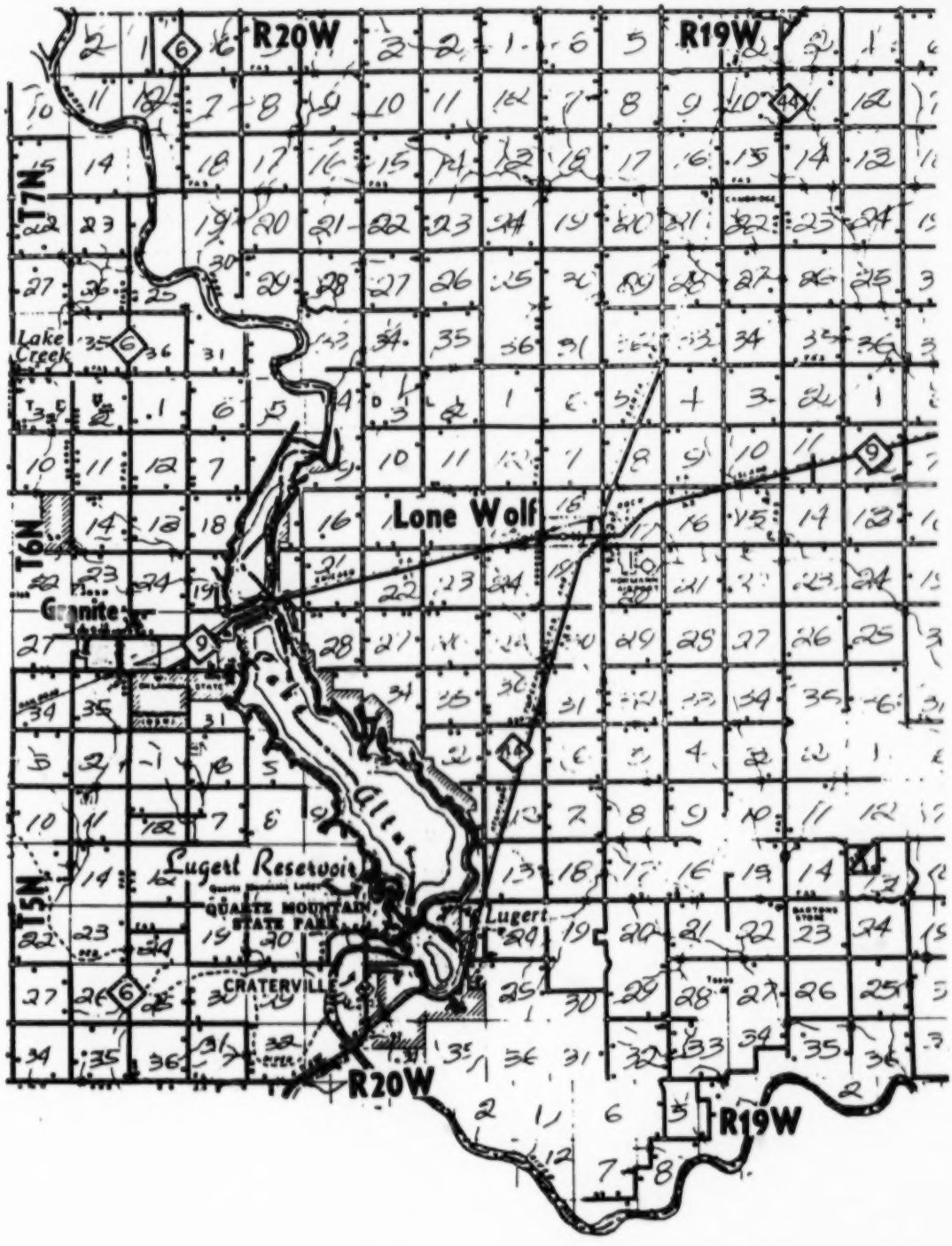
   c. Town of Granite _____

3. Approximately how many miles west of the Indian Meridian is the town of Lone Wolf?

4. Approximately how far north from the base line is the town of Granite?

PLT C - 5 - 22

ASSIGNMENT SHEET 4



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A CIMC "RAINBOW PROGRAM"

FOR STANDARDS OF TEACHING EXCELLENCE

One very important factor contributing to higher student performance is the expectation of parents and teachers. Experience suggests that teachers and parents who expect student success find that students perform better, attend class more regularly, have positive attitudes, and stay in school longer. The students' success and confidence in their ability to learn may cause additional growth and behaviors that exert a positive influence throughout life.

STUDENT'S PROMISE

Let it be publicly known that students in this program have high expec[illegible]

I recognize that America's future is dependent on my success in school.
I will attend school regularly.
I will keep regular study hours at home.
I will read each day at home.
I will never accept failure.
I will accept responsibility for my school challenges.
I will respect the rights and feelings of others at home, school, and work.
I will develop positive qualities in myself that my friends will admire.
If I have difficulty, I will insist on help with my school work.
If I have difficulty, I will always try harder.
I will ask my teacher for clear learning objectives.
I will practice good citizenship skills at home, school, and work.
I will keep my parents/guardians informed daily about my school activities.
I will develop goals for school, home, and work.
I will seek advice from my teachers, parents/guardians, and counselors on career guidance.
I will constantly practice the skills of a good student.

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